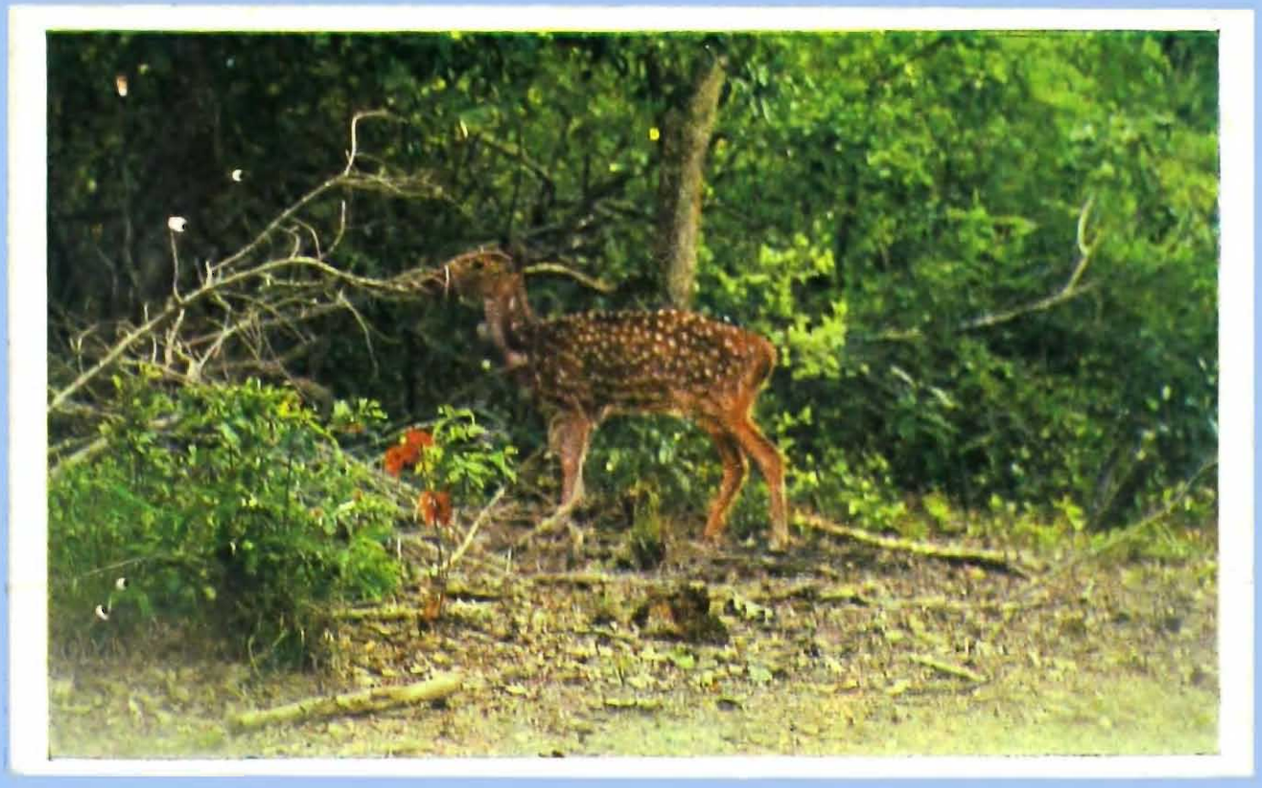
FAUNA OF CONSERVATION AREAS : 3

# FAUNA OF SUNDARBAN MANGROVE ECOSYSTEM, WEST BENGAL, INDIA



A. K. MANDAL AND N. C. NANDI

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## FAUNA OF SUNDARBAN MANGROVE ECOSYSTEM, WEST BENGAL, INDIA

By

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## EDITOR'S PREFACE

The Sundarban is considered to be the largest single mangrove belt of the world comprising an area of 9827 sq. km. and it occupies a position of importance as a tourist spot for the scenic beauty it provides and for the famous and majestic "Royal Bengal Tiger" found there; as such attracting a large number of tourists from all over the globe.

It can very well be said that in comparison to the well studied flora, the fauna from the mangroves of Sundarban proper has not drawn equal attention from concerned specialists.

The present authors have had the opportunity to undertake several field surveys both inside and outside the Project Tiger Area of Sundarban and to make observations in different seasons of the year. They have not only included their field observations but also consulted literature on the subject in fulfilling this long felt need of a comprehensive account of the fauna of Sundarban. While dealing with the fauna, the authors have restricted themselves mainly to Indian teritory of Sundarban which is approximately 4264 sq. km.

Several interesting observations on the wildlife, food-web, food habits and adaptations due to the environmental stress in this particular habitat have been narrated in a lucid manner, which I trust will bring the readers closer to "the Treasure Island of Sundarban", the land of myths and legends.

It is hoped that this book will provide wealth of information on the subject and not only be helpful to the specialists but also to the naturalists, tourists and other fellow workers interested in the conservation and utilization of natural resources of this Mangrove Ecosystem.

ASKET SINGH
*Jt. Director-in-charge,*
*Zoological Survey of India*

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## FAUNA OF SUNDARBAN MANGROVE ECOSYSTEM, WEST BENGAL, INDIA

### CONTENTS

# INTRODUCTION

Mangrove ecosystem is a very specialised environment occurring in between the land and the sea in the tropical and subtropical regions. It is a transitional ecotone which supports a unique variety of plant community collectively known as the mangrove. The mangrove plants are specially adapted to thrive under varying salinity, recurrent tidal inundation and periodic desiccation. The mangrove forests with their typical root-system play an important role in protecting and extending the coastline, by trapping sediments and binding soils. The mangrove ecosystem is also known to support fishery, by developing a detritus-based food-web and help regulating regional climate. It is the natural abode of many a groups of animals and a large number of species are known to feed, breed and take shelter in this ecosystem.

During the earlier part of the present century, a good number of accounts on various groups of animals were published, through the studies conducted by Alcock, Annandale, Kemp, Hora and others on the fauna of Sundarban, but most of these works made no reference to the mangroves. Recently Prof. Amalesh Choudhury and his co-workers have started studying the faunal components of Sundarban mangroves with special reference to plankton and benthos from Sagar Island and its adjacent mangrove inhabited islands. However, all these works, both previous and the recent-ones, are scattered and related to one or a few groups of organisms, or on the faunal community of a particular region. As no comprehensive account on the fauna of Sundarban mangrove ecosystem is available, hence this present communication.

The present work is based on our own observations made for the last ten years as well as on the basis of information already available in the literature. All possible efforts have been made to provide a complete list of the fauna occurring and/or visiting this aqua-terrestrial mangrove ecosystem of Sundarban; but it may not be complete in all respects for certain groups of invertebrates. Anyhow enough information on the representative species or the group of invertebrates is now available to form a basis for further study on these animals. The parasitological fauna (viz., intestinal

amoebae, haemoflagellates, sporozoans, trematodes, cestodes, nematodes and acanthocephalans) inhabiting the animals of Sundarban, though discussed in the text, is not represented in the faunal list appended, since several fishes, turtles, birds, bats and cetaceans may have acquired the infections elsewhere.

## A BRIEF REVIEW OF THE PREVIOUS WORKS

Mangrove environment plays a very vital role in the biology of its faunal component. But this unique ecosystem had not so far drawn the attention it deserved so far as its faunal component is concerned until recently. However, the floristic components of Indian as well as of Sundarban mangrove forests have been well documented in the literature (Roxburgh, 1832; Prain, 1903, 1905; Blatter, 1905; Mukherjee, 1960, 1966; Patil, 1961; Berry, 1963; Sidhu, 1963; Banerjee, 1964; Guhabakshi and Sen, 1969; Ahmad, 1972; Blasco, 1975, 1977; Mukherjee, 1975; Chanda, 1977; Mahapatra and Chakravarty, 1977; Mukherjee and Mukherjee, 1978; Mitra and Banerjee, 1979, Choudhury, 1979; Untawale, 1980; Naskar and Guhabakshi, 1982).

Earlier works on the fauna of this region had hardly made any reference to the mangroves, even though there appear to be about 700 publications, concerning bioecology, systematics and fishery aspects. Stoliczka (1869) was the pioneer in exploring the malacofauna of brackishwater systems of lower Bengal. It is followed by the works of Alcock (1896-1906) on crustaceans, Annandale (1907-1925) on Hydrozoa, Polyzoa, Entoprocta etc., Kemp (1913-1923) on crustaceans and Hora (1929-1955) on fishes who have contributed much to our knowledge of these estuarine animals occurring in this part of Sundarban.

Studies on fauna with special reference to estuarine biology of the Sundarban mangroves have recently been given a boost by Choudhury and his co-workers (1978 - onwards). Several Ph.D. theses based on materials collected from the mangrove ecosystems of Sundarban have been made especially on Microbiology, Hydrobiology (Plankton & Benthos), Plankton productivity and Estuarine ecology. These unpublished works contain a wealth of information in their specialised fields. Some of the recent publications are those of Bhunia and Choudhury (1981, 1982, 1983) on zooplanktons, Baidya and Choudhury, (1984 a, b, 1986) on zooplankton and Chakraborty and Choudhury (1986) on the distribution of fiddler crabs.

A large number of works on different aspects of zoology and fishery are available in literature; these though originating from Sundarban could not be identified from their titles. A wealth of information was gathered from such sources which is of immense value for further faunistic studies of the mangrove habitat. It was beyond the scope of this study to include and/or review all such publications, however, important and recent articles have been referred herein. Nandi and Misra (1987) have recently complied a bibliography of the Indian part of Sundarban with special reference to fauna, in which literature pertaining to zoological researches, faunal studies and fishery have been dealtwith.

Studies on the protozoan fauna of the Sundarban mangrove forest have been made on gymnamoebae by Choudhury and Ghosh (1985) and Ghosh *et al.* (1985), commensal ciliates of mangrove molluscs by Jamadar and Choudhury (1978, 1980, 1985, in press), coccidian parasites of birds by Mandal (1965, 1971), blood parasites of fishes by Mandal (1984), blood parasites of birds (Nandi *et al.,* 1984), myxosporidan parasites of fishes by Choudhury and Nandi (1973), parasitofauna of wild mammals by Mandal and Choudhury (1982, 1984, 1986) and on termite flagellates by Tiwari (1978).

After Annandale (1915), Misra (1984) and Misra and Soota (1981) have explored the coelenterate fauna while Rao and Misra (1983) have described a new species of *Halammohydra* from Sagar Island.

Helminth parasites of *Hilsa* and other fishes from Hooghly estuary were recorded by Tripathi (1954, 1956, 1959), Pal (1963), Laha *et al.* (1971) and Zhukov (1977). Recently, Roy and Choudhury (1983, 1985) have studied the trypanorhynch cestode parasites of commercially important fishes visiting Hooghly estuary. Soil nematodes from mangrove environment of Sundarban have been investigated by Sinha, Choudhury and Baqri (1985) and Datta and Soota (1960) have described two new species of Acanthocephala from a fish, *Scatophagus argus.*

Investigations on polychaetes were made by Misra *et al.* (1983) and Misra and Choudhury (1986); on echiuroids by Haldar (1978) and Das (1980); on sipuncula by Haldar (1985) and on macrobenthos in general by Mandal and Misra (1986)

Recent and worthwhile works on malacological fauna of Sundarban mangrove are those of Subba Rao *et al.* (1983) and Nandi *et al.* (in press).

The crustacean fauna from this region is vast and varied and includes prawns, shrimps, crabs, lobsters, hermit crabs, cirripedes, isopods, mysids, etc. After Alcock's work on the Indian Decapod Crustacea (1896-1901, 1905, 1906), some valuable contributions on other crustaceans were made on the taxonomy of Amphipoda by Annandale (1908); of Brachyura by Kemp (1923) and Chopra (1933, 1934a, 1935); of Cirripedia by Nilson-Cantell (1938) and of Stomatopoda by Chopra (1934b). Much work has been done on prawns and their fisheries from Hooghly estuarine system by Rao (1969) and Rajyalakshmi (1962, 1980).

Insect fauna had not received any attention until recently. Ray and Choudhury (1985 a, b, c) have just initiated investigation on dipterans in Sundarban and Sanyal (1980) has studied soil dwelling oribatid mites occurring in the Gangetic delta.

Singh and Choudhury (1984), reporting the occurrence of an enteropneust hemichordate in the mangrove swamps of Sundarban, is the only work on systematics of Hemichordata.

Extensive studies have been made on fish and fisheries on the Hooghly-Matlah estuarine system. Many fishes of the river Ganges described by Hamilton-Buchanan (1922) are known from estuaries of Sundarban mangrove environment. Annandale (1907, 1922) and Hora (1933, 1934a, b, 1935, 1940, 1943) and more recently several authors viz., Gupta (1966, 1967), Babu Rao and Sinha (1968), Sinha and Babu Rao (1969), Talwar and Joglekar (1970), Talwar and Roy (1980), Chatterjee (1978) and Dhanze (1981) have contributed to the study of fish fauna of Hooghly-Matlah rivers and Gopalakrishnan (1973), Sen (1975), Naskar and Chakraborty (1984) have reported on the fish and fishery resources of the Sundarban delta.

No report primarily devoted to the study of amphibians has so far been made from Sundarban. Mukherjee (1975), however, has reported on a few species in his account of Sundarban biota. Comprehensive account on reptiles is also lacking. Acharji and Mukherjee (1964), Saha (1983) and Talukdar (1982) have, however, reported on the occurrence of some reptiles in Sundarban.

Law (1954, 1956), Mukherjee (1959) and Jackson (1976) have contributed to the ornithology of the Sundarban. Comprehensive account of mammalian fauna from Sundarban is also not so far been available.

However, Mukherjee (1970, 1971, 1981), Sanyal (1983), and Chaudhury and Chakraborti (1981) have reported on the wildlife of Sundarban and Mandal (1964) and Mukherjee and Gupta (1965) have studied the Rhesus macaque of Sundarban. A comprehensive general account of Sundarban has recently been completed by Mandal and Ghosh (Ms.).

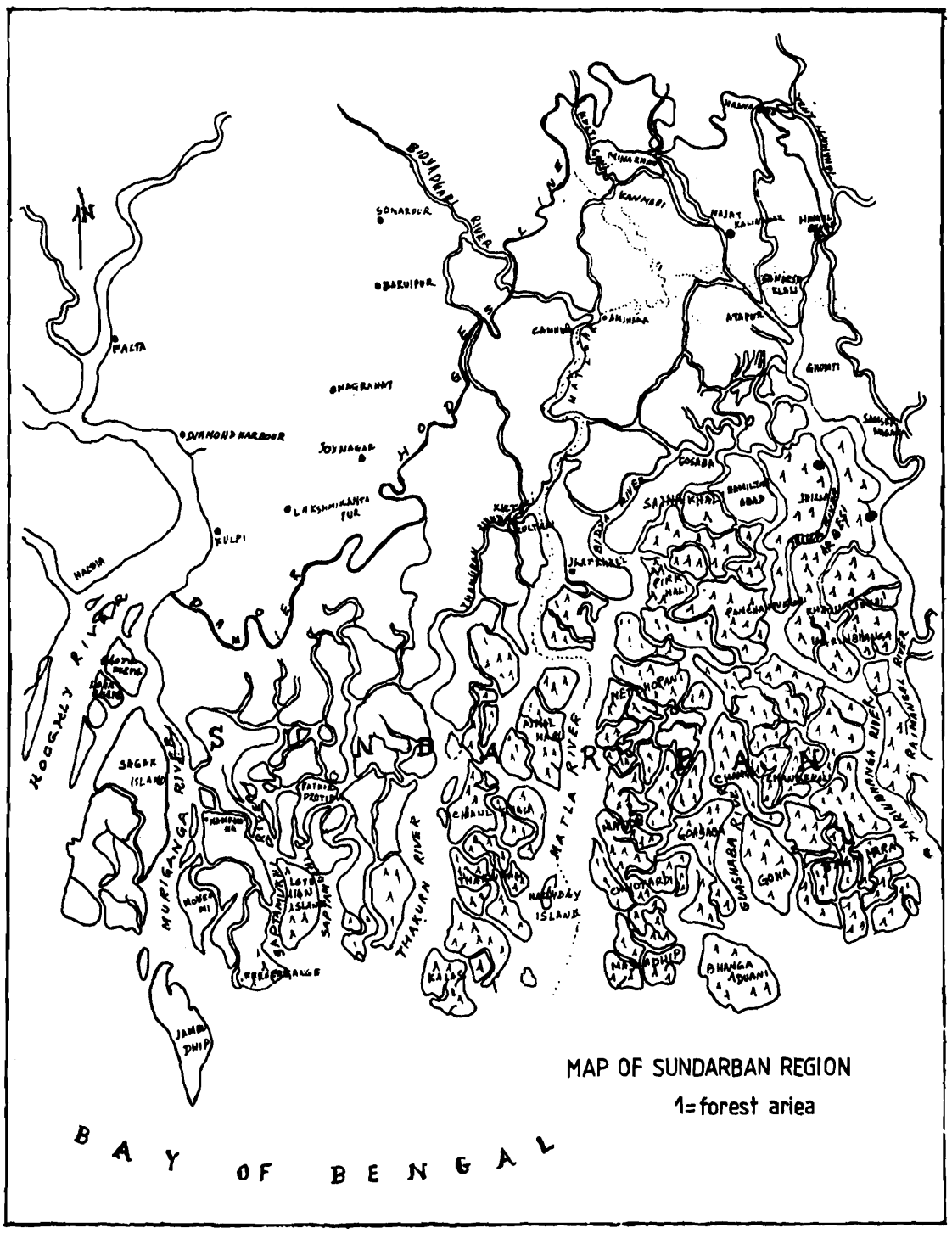
## PHYSICAL FEATURES, SOIL, CLIMATE, ETC.

### A. PHYSICAL FEATURES

Sundarban is characterised by a group of islands facing the sea and supports the largest mangrove belt of the world (Text fig. 1). It starts from the mouth of the river Hooghly on the West and extends upto the river Meghna in the East-covering four districts viz., North and South 24 Parganas, within the Indian territory, and Khulna and Bakhergunge (now Barisal) districts in Bangladesh. At present the total forest cover is about 9827 sq. km. and confined to 24 Parganas (South and North) and Khulna districts. Rest of the area has mostly been reclaimed either for agriculture or for human settlement. Of the total forest area, we are fortunate enough to have 4264 sq. km. within the Indian limits. It lies between 21°0′ - 21°21′ N latitudes and 88°0′-89°0′ E longitudes.

This landmass is formed due to the deposition of silt brought down by the rivers Brahmaputra and Ganga from the Himalayas along with their net work of tributaries. A number of theories have been put forward regarding the origin of this landmass. It is presumed that this tidal swamp was extended upto Rajmahal Hill in the past and filled up in the later part of Tertiary period (35 million years). Previously it was represented as sag or depression in the coast which was ultimately filled up by thick sediments of recent Pleistocene origin. The interaction between the sea and freshwater as well as the silt brought down by the rivers play an important role in the formation of this delta along with ebbs and tides therein. Silt diposition is still continuing and is very much active as evidenced by the formation of new Moore Island which has come up recently. Whatever might be the cause of origin of this deltaic alluvium it has been estimated that the present day Sundarban has got formed about 4000 years ago.

Morgan and McIntire (1959), Mukherjee and Mukherjee (1978) and Sanyal, Banerjee and Chowdhury (1984) are of the opinion that there appeared geomorphological changes due to east-ward tilting of Bengal basin.




Text-fig. 1. Map showing the Sundarban Region.

Consequently changes occurred in the course of the main river flow in recent geological past resulting in the reduction of freshwater supply to westward rivers. It has ultimately given rise to accretion of river mouth followed by the subsequent changes in the biotic community, keeping the biotope and bioresources under constant environemtal stress. With the shifting of the plant communities in quicker successions due to increase in salinity, rate of erosion, etc. and the associated fauna, the whole habitat manifests a dynamic changing face.

## B. ESTUARY

It is evident that this delta is the product of the tidal estuary. The estuary can be defined as an inlet where the sea water is mixed with the inflow of freshwater yielding in variable salinity. Major portion of the area is washed off or inundated for greater or longer part of the day by the high tides and ebb tides within 24 hours. The tide also varies in the area in different seasons. During monsoon (July-October) when there is huge freshwater discharge due to rain, the high tide reaches upto the highest level but the low tide does not reach the lowest level. During postmonsoon (November -February) it is quite opposite, the high tide does not reach the highest level but the low tide reaches the lowest level. During premonsoon (March -June) the high tide goes upto highest level so also the low tide which goes down to the lowest level. The height of water due to tide varies between 3 and 5 metres. Maximum spring tide is felt during postmonsoon popularly known as *'Bhadra Kotal'* (during 1st week of September). In this active zone, the rivers with their tributaries form a close network throughout this unique ecosystem. The major rivers are Saptamukhi, Thakuran, Matlah, Guasaba and Raimangal within the Indian limit. Saptamukhi orginates from near Sultanpur, South 24-Parganas and is connected with Muriganga (Baratla), a branch of the Hooghly river, through the Hatania-Duania river and Diograkhal. Afterwards it reaches the sea with a wide mouth by traversing about 8 km. The river Thakuran originates from near Joynagar, South 24-Parganas and having a number of connections with Saptamukhi, and before reaching the sea it takes the name Jamira. The other famous river is the Matlah. It is formed out of three rivers Bidyadhari, Khuratya and Rampurakhal at Canning, South 24-Parganas. It is well connected with the river Bidya and falls in the sea with a wide mouth. A large number of canals from the Raimangal and Matlah rivers join together to form the river Guasaba. After originating from near Sahebkhali, North 24-Parganas, the

river Raimangal connects the river Rampurakhal through Barakalagachia. It also connects the Guasaba river by the river Terobanki and Harinbhanga. This Harinbhanga actually demarcates Bangladesh and India border.

These rivers form a unique complex with network of tributaries, and jointly known as Hooghly-Matlah estuary and create a buffer zone which can withstand the thrust of the mighty sea on one hand and freshwater load from the upper stretch of the river Hooghly as well as rain water during monsoon, on the other.

## C. SOIL

The Sundarban deltaic alluvium is formed out of the silt brought from the Himalayas. The soil is mainly of fine silty clay in northernmost part. Peaty deposits are found in the middle and in swampy areas, while sandy clay with sand dunes are seen towards the seaface. The new alluvium can be subdivided into (i) the area which annually overflows and is renewed by the rivers and (ii) the area devoid of inundation. The colour of the silt is pale brown, grey to greyish black. The loamy soil, also called as black soil or sodium clay due to the presence of ferrous sulphide, is the common adhesive or sticky clay of the area. The upper layer of the soil is grey to greyish black, the subsoil is grey with mixing up of clay with sand. After certain depth, the size of sand grains vary and is grey to bluish grey in colour. Upto a depth of 10 metres alternate layers of clay, sand and silt could be noticed. The soil of the mangrove forest is considered as 'young soil', with less oxygen content. Roychoudhury *et al.* (1963) have reported that in the soil, nitrogen varies from 0.02 to 0.9%, phosphate from .06 to 0.1%, potash from 0.1 to 0.5%, calcium oxide from 0.0 to 6% and carbon from 0.5 to 1.0%. The overall pH varies from 7 to 8%. The humus content is generally high. Recently, Sahoo, Sah and Gupta (1986) have estimated, .055-.082% nitrogen at a depth of 15-25 cm at Prentice and Lothian islands of Sundarban, and organic carbon from .45 to 1.86%. Salinity depends upon the freshwater flow. The torrential rain particularly during monsoon period diminishes the surface soil salinity and play a major role in making the soil free of saline. On the basis of slainity the soil can be divided into (i) saline soil, where there is inundation or flushing of brackishwater, and (ii) saline-alkali soil, when the sodium salts flow over a fresh lowland enriched with alkali and nitrogen ions. Non-saline alkali soil is mainly formed when the rain water completely washes away the salts. The degraded alkali soil is produced due to

decomposition of organic matter lying within depth of 2 metres. The mangrove soil is soft, peaty, clayey or sandy. The size of the particle is of prime importance in this substratum which primarily governs the soil condition.

Recently, Bandyopadhyay (1984) has reported the soil and water characteristics of mangrove forest of Sundarban. He divided the rivers flowing within different blocks of Sundarban Tiger Project areas as outer, middle and inner estuaries. The outer estuaries are in Mayadwip and Gona blocks, and the inner estuaries lie in Pirkhali and Jhila blocks. Salinity of river water varies seasonally as well as with the distance from the sea. It is higher in the outer estuaries than the inner ones. He recorded insignificant variation in salinity within the outer and mid-estuaries but salinity significantly varies in the inner estuaries.

The salinity of the soil profile of outer estuarine blocks is less but gradually increases from mid to the inner estuarine blocks.

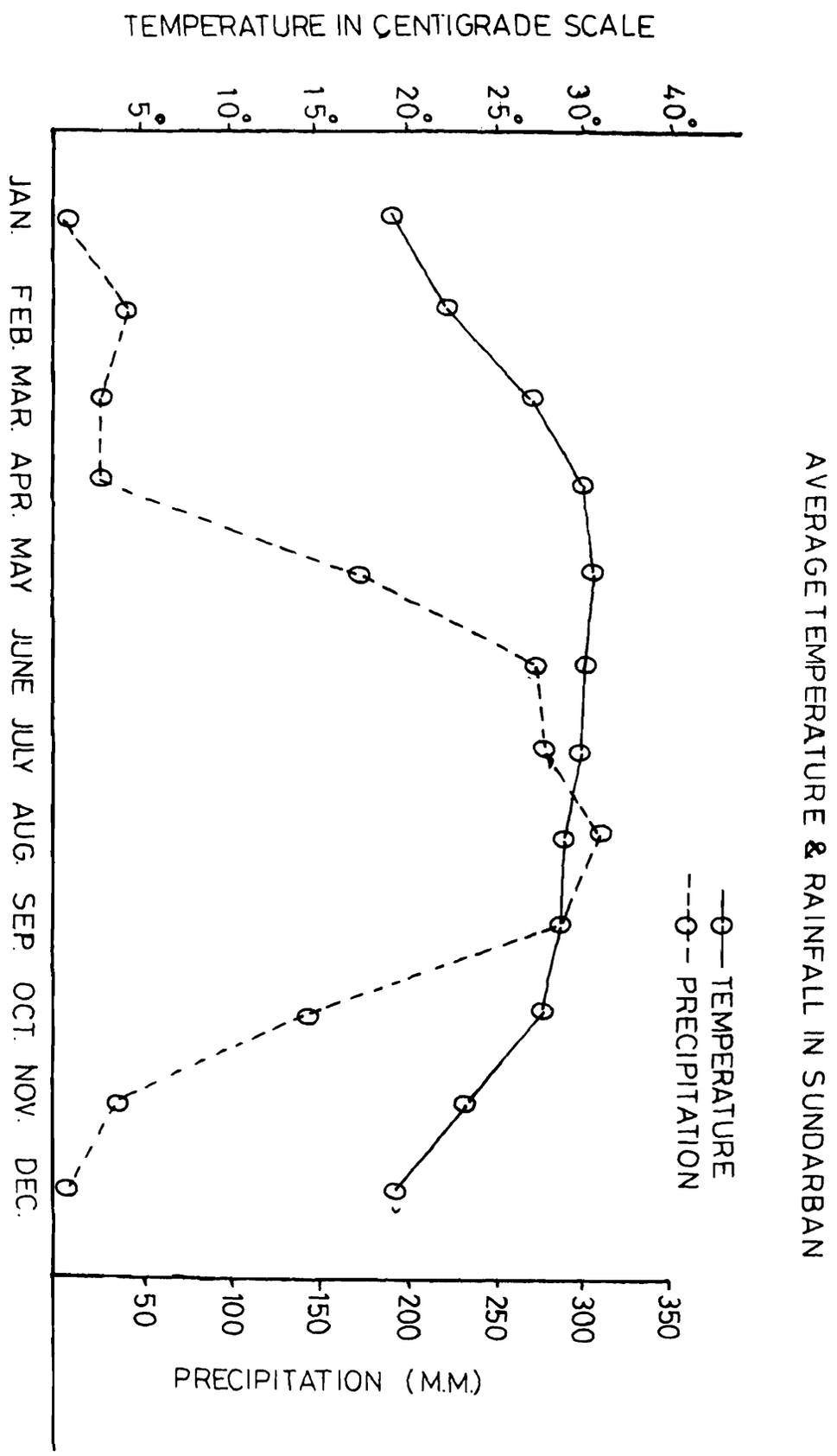
In general pH variation is less, so also the organic carbon. The dominant salt is $Na^+$ which increases with the increase in depth in the mid and inner areas, as also the chloride. Silt and clay contents are more in the mid and inner estuarine blocks than in the outer estuarine region.

## D. CLIMATE

Inspite of its close proximity to the Tropic of Cancer, the extreme climate does not prevail here because of its location nearer to the sea as well as due to tidal flushing of innumerable rivers and creeks inside.

Monsoon prevails for almost half of the year with high rate of humidity. It starts from July and usually prolongs upto October, with occasional rain throughout the year. This monsoon is brought about by the South-West wind. The postmonsoon period is characterised by cold weather from November to February of which December-January months are considered as winter months with low temperature and less precipitation. Wind from North-East blows in this area from mid October to mid March. The premonsoon period is predominantly dry, starting from March to June and accompanied with occasional violent thunderstorms, locally known as *Kal Baishaki* (Nor' Wester). The hail-storms are also not uncommon.

The mean maximum temperature is 29°C (June-July) and mean minimum is 20°C (December-January ) The average rainfall of the area is about 180 cm. Humidity ranges normally between 70 and 88% (Text Fig. 2).




Text-fig. 2. Graph showing average temperature and rainfall in Sundarban throughout the year.

### E. HYDROLOGY

Due to heavy rain and variable tidal influx, the estuaries of this region have become dynamic. A rhythmic cyclical pattern is noticed in the hydrology of these rivers. Temperature, salinity, pH and turbidity vary according to the horizontal zonation of a river from the sea, and freshwater flow due to rain. Sometimes this variation is also noticed even at different levels of the water column (vertical zonation) of a particular region in an estuary. Recently, Sarkar, Singh and Choudhury (1986) have noted the hydrological parameters at a few stations of Sagar Island during March, 1980 - February, 1981 and found that water temperature varied from 21.7°C to 31.2°C, salinity from 3.6 ppt to 26.08 ppt, pH from 7.9 to 8.3 and turbidity between 3.7 cm. and 9.9 cm.

## VEGETATION

The variable salinity and pH, sandy or loamy soil with different grades of subsurface nutrient, weather hazard, etc. of this area support specialised group of plants known as Mangrove (Plate 1, fig. 1).

The characteristic features of mangrove species are the typical leathery, dark, thick evergreen leaves, with deeply embedded stomata and aqueous tissue. The cable root along with stilt roots (Plate 1, fig. 2) and pneumatophores (Plate 2, fig. 1), are the other characteristic features of these plants. They can also tolerate high salinity (Chapman, 1976).

Out of the total land area of 87617 sq. km. of West Bengal, the forest cover is 11970 sq. km. and the mangrove occupies 4264 sq. km., exclusively restricted to this deltaic region.

The constant interaction with this variable and everchanging condition, the mangrove (Table 1) has associated with some other plants to grow within this ecosystem and are collectively known as Halophyte.

This plant community suffers from an environmental stress in this area due to periodical inundation, enriched with excess amount of dissolved salts in the soil.

Out of a total of about fifty species of true mangrove plants of the world as many as twenty six are found in Sundarban (Table 1). However, there are about twenty species of mangrove associates occurring in this area.

Table 1. A list of mangrove (exclusive) plant species available in Sundarban.

| Family | Locai Name | Scientific Name |
|---|---|---|
| (Arranged in order of abundance) | | |
| Rhizophoraceae | Garjan | *Rhizophora mucronata* Poir. |
| | — | *R. apiculata* Bl. |
| | Goran | *Ceriops decandra* (Grift.) Ding Hou |
| | Mot goran | *C. tagal* (Per.) Robins |
| | Khagra | *Bruguiera gymnorrhiza* (L.) Savigny |
| | | *B. parviflora* (Roxb.) W & A. ex Griff. |
| | | *B. cylindrica* (L.) Bl. |
| | | *B. sexangula* (Lour.) Poir. |
| | Goria | *Kandelia candel* (L.) Druce |
| Euphorbiaceae | Gnewa | *Excoecaria agallocha* L. |
| Sonneratiaceae | Keora | *Sonneratia apetala* Buch.-Ham. |
| | Ora | *S. caseolaris* (L.) Engl. |
| Verbenaceae | Baen | *Avicennia officinalis* L. |
| | | *A. alba* Blume |
| | Kala Baen | *A. marina* (Forsk.) Vierh. |
| Myrsinaceae | Khalshi | *Aegiceras corniculatum* (L.) Blacos. |
| Palmae | Hental | *Phoenix paludosa* Roxb. |
| | Golpata | *Nypa fruticans* Wurmb. |
| Plumbaginaceae | Tora or Satari | *Aegialitis rotundifolia* Roxb. |
| Meliaceae | Dhundul | *Xylocarpus granatum* Koen |
| | Passur | *X. mekongensis* Pierre |
| | Amur | *Aglaia cucullata* (Roxb.) Pellegrin |
| Combretaceae | Kripa | *Lumnitzera racemosa* Willd. |
| Tilaceae | Kedar Sundari | *Brownlowia tersa* (L.) Koster. |
| Leguminaceae | Singra | *Cynometra iripa* Kostel |
| Sterculiaceae | Sundari | *Heritiera fomes* Buch.-Ham. |

The dominating plant species along the banks of the river mouth are *Avicennia marina, Aegialitis rotundifolia, Bruguiera cylindrica, B. parviflora, Ceriops tagal, Avicennia alba* and *Lumnitzera racemosa.* Middle zone of the rivers is occupied by many creeks and channels which yield several estuarine mangrove fringes and islets. This zone is dominated by species like

*Rhizophora apiculata, Ceriops decandra, Kandelia candel, Xylocarpus granatum, Bruguiera gymnorrhiza* and *Aegiceras corniculatum.*

Mangroves are characterised by stilt roots and vivipary (Plate 3) specially where there is greater tidal forces of the creeks and channels. The vivipary is found among the genera *Rhizophora, Bruguiera, Ceriops, Aegialitis, Kandelia* and *Aegiceras* specially important for anchorage with the pencil like roots developed before detachment from the parent body. Inland tidal flats of inner estuaries with elevated land, having low tidal action and more freshwater influx, favour *Heritiera fomes* (Plate 2 fig. 3) and *Nypa fruticans* (Plate 4, fig. 1) plant species associated with others. In such places, *H. fomes* combines with *Cynometra iripa* and *Avicennia officinalis* whereas in places with high salinity and low elevation *H. fomes* combines with *Ceriops decandra, Excoecaria agallocha* and *Xylocarpus granatum.*

In the swampy areas with occasional inundation, *Excoecaria agallocha* combines with *Phoenix paludosa* (Plate 4, fig. 2). A remarkable species of this area is the *Sonneratia apetala,* found along the large river banks. In the mudflats it is frequently found in combination with *Avicennia.* Well known shrub in this region is *Aegialitis rotundifolia* and *Acanthus illicifolius.* Among grasses, *Porteresia* (= *Oryza*) *coarctata* is predominent, and grows on the banks where water reaches only at the time of high tide specially during the rains. The genera like *Derris, Hibiscus, Dalbergia, Surcolobus* and *Sesuvium* are found as good climbers in this forest.

In the upper, middle and inner estuaries plant species are distributed in accordance with the rate of tidal inundation, nature of sediment and salinity of the soil. The rate of deposition of silt, the formation of firm substrata and the erosion of soil are considered as deciding factors for the distribution of plants in this ecosystem.

## FAUNA

Being a very specialised environment, mangrove ecosystem supports a wide assemblage of animal communities (Tables 2 & 3). It is the abode of many groups of animals which live entirely within the mangrove, several others visit this zone either to feed or to breed but live elsewhere, still others use the mangrove habitat for shelter and/or roosting.

Table 2. List of fauna of the forested and scanty mangrove ecosystem of Sundarban, West Bengal

| Family and Species | Mangrove habitat | | Remarks |
|---|---|---|---|
| | Forest zone | Scanty zone | |
| 1 | 2(i) | 2(ii) | 3 |
| PHYLUM : PORIFERA | | | |
| *Spongilla alba* Cartes (= *S. lacustris, V. bengalensis* Annandale) | - | + | Benthos |
| PHYLUM : CNIDARIA | | | |
| CLASS : HYDROZOA | | | |
| ORDER : ATHECATA | | | |
| FAMILY : HYDRIDAE | | | |
| *Halammohydra sagarensis* Rao and Misra | + | + | Benthos |
| CLASS : SCYPHOZOA | | | |
| ORDER : RHIZOSTOMEAE | | | |
| FAMILY : RHIZOSTOMATIDAE | | | |
| *Acromitus rabanchatu* Annandale | + | - | Pelagic |
| CLASS : ANTHOZOA | | | |
| SUBCLASS : ZOANTHARIA | | | |
| ORDER : ACTINIARIA | | | |
| FAMILY : EDWARDSIIDAE | | | |
| *Edwarsia jonesii* Sheshiya and Cuttress | + | + | Benthos |
| FAMILY : HALIACTIDAE | | | |
| *Pelocoetes* exul (Annandale) | + | + | Benthos |
| *Phytocoetes gangeticus* (Annandale) | + | + | Benthos |
| *Phytocoeteopsis ramunnii* (Panikkar) | + | + | Benthos |
| FAMILY : DIADUMENIDAE | | | |
| *Diadumene* sp. | + | + | Benthos |
| PHYLUM : CTENOPHORA | | | |
| CLASS : TENTACULATA | | | |
| ORDER : CYDIPPIDA | | | |
| FAMILY : PLEUROBRACHIDAE | | | |
| *Pleurobrachia globosa* var *bengalensis* Annandale and Kemp | + | + | Plankton |
| PHYLUM : PLATYHELMINTHES | | | |
| CLASS : TURBELLARIA, Flat Worms | | | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| Undetermined species | + | + | Meiofauna |
| PHYLUM : RHYNCOCOELA (NEMERTEA) | | | |
| Undetermined species | + | + | Meiofauna |
| PHYLUM : ASCHELMINTHES<br>CLASS : ROTIFERA, Wheel animalcules | | | |
| *Brachionus* spp. | + | + | Plankton |
| *Keratella* spp. | - | + | Plankton |
| *Asplancha* spp. | + | + | Plankton |
| *Notholen* sp. | + | + | Plankton |
| CLASS : NEMATODA, Round worms | | | |
| *Oncholaimus indicus* Von Linstow | - | + | Meiofauna |
| *Mylonchus* spp. | - | + | Meiofauna |
| PHYLUM : CHAETOGNATHA, Arrow worms | | | |
| *Sagitta bedoti* Beraneck | + | + | Plankton |
| *Sagitta enflata* Grassi | + | + | Plankton |
| PHYLUM : BRYOZOA (ECTOPROCTA) | | | |
| *Victorella pavida* Kent | + | + | Benthos |
| *Bowerbankia caudata* Hincks | + | + | Benthos |
| *Membranipora bengalensis* Kent | + | + | Benthos |
| PHYLUM : BRACHIOPODA, Lamp shells | | | |
| *Lingula anatina* (Linn.) | - | + | Benthos |
| PHYLUM : MOLLUSCA, Molluscs<br>CLASS : GASTROPODA<br>ORDER : ARCHAEOGASTROPODA<br>FAMILY : ACMAEIDAE | | | |
| *Potamacmaea fluviatilis* (Blanford) | | + | Benthos |
| FAMILY : CYCLOSTREMATIDAE | | | |
| *Cyclostrema (Tubiola) innocens* Preston | | | |
| FAMILY : NERITIDAE | | | |
| *Nerita articulata* (Gould) | + | + | Benthos |
| *Neritina smithi* Wood | + | + | Benthos |
| *Neritina violaceae* (Gmelin) | + | + | Benthos |
| *Pseudonerita sulculosa* (Von Martens) | | + | Benthos |
| *Pseudonerita obtusa* (Sowerby) | - | + | Benthos |
| *Septaria caerulescens* (Sowerby) | - | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : MESOGASTROPODA | | | |
| FAMILY : LITTORINIDAE | | | |
| *Littorina melanostoma* Gray | + | + | Benthos |
| *L. carinifera* (Menke) | + | + | Benthos |
| *L. undulata* Gray | + | + | Benthos |
| *L. scabra* (Linn.) | + | + | Benthos |
| FAMILY : STENOTHYRIDAE | | | |
| *Gangetica miliacea* (Nevill) | + | + | Benthos |
| *Stenothyra blanfordiana* (Nevill) | - | + | Benthos |
| *S. deltae* (Benson) | - | + | Benthos |
| *S. gangetica milicea* (Nevill) | - | + | Benthos |
| *S. soluta* Annandale and Prasad | - | + | Benthos |
| *S. woodmasoniana* Nevill | - | + | Benthos |
| FAMILY : ASSIMINEIDAE | | | |
| *Assiminea beddomeana* Nevill | + | + | Benthos |
| *A. brevicula* (Pfeiffer) | + | + | Benthos |
| *A. francesiae* (Gray) | - | + | Benthos |
| *A. microsculpta* Nevill, | - | + | Benthos |
| *A. hungerfordiana* Nevill, | - | + | Benthos |
| *A. theobaldiana* Nevill, | - | + | Benthos |
| *A. woodmansonia* Nevill, | - | + | Benthos |
| FAMILY : THIARIDAE | | | |
| *Thiara (Mainwaringia) paludomoides* (Nevill) | - | + | Benthos |
| FAMILY : POTAMIDIDAE | | | |
| *Cerithidea obtusa* Lamarck, | + | + | Benthos |
| *Cerithidea cingulata* (Gmelin) | + | + | Benthos |
| FAMILY : NATICIDAE | | | |
| *Natica qualteriana* Recluz | + | + | Benthos |
| *N. tigrina* (Roeding) | + | + | Benthos |
| FAMILY : NASSARIIDAE | | | |
| *Nassarius (Aciculina) subconstrictus* (Sowerby) | + | + | Benthos |
| *N. ennurensis* (Preston) | + | + | Benthos |
| *N. stolatus* (Gmelin) | + | + | Benthos |
| *N. orissaensis* (Preston) | - | + | Benthos |
| FAMILY : MELONGENIDAE | | | |
| *Pugilina cochlidium* (Linnaeus) | - | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : NUDIBRANCHIA | | | |
| FAMILY : CUTHONIDAE | | | |
| *Cuthona annandalei* Eliot | | + | Benthos |
| ORDER : BASOMMATOPHORA | | | |
| FAMILY : AMPHIBOLIDAE | | | |
| *Amphibola burmana* Blanford | | + | Benthos |
| FAMILY : ELLOBIIDAE | | | |
| *Ellobium (Auricula) gangeticum* (Benson) | | + | Benthos |
| *E. aurisjudae* (Linn.) | | + | Benthos |
| *E. (A.) translucens* Annandale & Prasad | | + | Benthos |
| *Cassidula bensoni* Pfeiffer | | + | Benthos |
| *C. nucleus* (Gmelin) | | + | Benthos |
| *Melampus pulchellus* Petit | | + | Benthos |
| *M. singaporensis* Petit | | + | Benthos |
| *Pythia plicata* (Gray) | | + | Benthos |
| ORDER : SOLEOLIFERA | | | |
| FAMILY : ONCHIDIIDAE | | | |
| *Onchidium tenerum* Stoliczka | + | + | Benthos |
| *O. tigrinum* Stoliczka | + | + | Benthos |
| *O. typhae* Buchaman | | + | Benthos |
| *O. verruculatum* Cuvier | | + | Benthos |
| ORDER : CEPHALASPIDEA | | | |
| FAMILY : ATYIDAE | | | |
| *Haminea crocata* Pease | + | + | Benthos |
| CLASS : BIVALVIA | | | |
| ORDER : ARCOIDEA | | | |
| FAMILY : ARCIDAE | | | |
| *Anadara granosa* (Linn.) | | + | Benthos |
| ORDER : MYTILOIDEA | | | |
| FAMILY : MYTILIDAE | | | |
| *Modiolus striatulus* (Hanley) | + | + | Benthos |
| *M. undulatus* (Dunker) | + | + | Benthos |
| FAMILY : ANOMIIDAE | | | |
| *Enigmonia aenigmetica* (Holten) | | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : OSTREIDAE | | | |
| *Crassostrea gryphoides* var *cuttackensis* Newton & Smith | + | - | Benthos |
| *C. palmepes* (Sowerby) | + | - | Benthos |
| *Saccostrea cuculata* (Born) | + | + | Benthos |
| FAMILY : CORBICULIDAE | | | |
| *Geloina bengalensis* (Lamarck) | | + | Benthos |
| FAMILY : VENERIDAE | | | |
| *Meretrix meretrix* Linn. | + | + | Benthos |
| *Dosinia (Sinodia) trigona* (Schroter) | + | + | Benthos |
| *Pelecyora trigona* (Reeve) | + | + | Benthos |
| *Paphia undulata* (Born) | - | + | Benthos |
| FAMILY : DONACIDAE | | | |
| *Donax incarnatus* Schroter | + | - | Benthos |
| FAMILY : SEMELIDAE | | | |
| *Theora opalina* (Hinds) | - | + | Benthos |
| FAMILY : TELLINIDAE | | | |
| *Tellina (Pharaonella) iridescens* (Benson) | + | + | Benthos |
| *Macoma birmanica* (Philippi) | + | + | Benthos |
| *M. qubernaculum* Hanley | + | + | Benthos |
| *Strigilla (Aeretica) splendida* Anton | - | + | Benthos |
| FAMILY : GLAUCONOMIDAE | | | |
| *Glauconome cerea* Reeve | - | + | Benthos |
| FAMILY : SOLENIDAE | | | |
| *Solen kempi* Preston | - | + | Benthos |
| FAMILY : CULTELLIDAE | | | |
| *Tanysiphon rivalis* Benson | - | + | Benthos |
| *Siliqua albida* Dunker | - | + | Benthos |
| *Pharella javanica* (Lamarck) | + | + | Benthos |
| FAMILY : CORBULIDAE | | | |
| *Corbula gracilis* Preston | - | + | Benthos |
| *C. alcocki* Preston | - | + | Benthos |
| *C. calcaria* Preston | - | + | Benthos |
| *C. abbreviata* Preston | - | + | Benthos |
| *C. feiferi* Preston | - | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : MYIDAE | | | |
| *Sphenia pedata* (Linn.) | + | + | Benthos |
| FAMILY : PHOLADIDAE | | | |
| *Martesia striata* (Linn.) | + | + | Benthos |
| *Barnea candida* (Linn.) | + | + | Benthos |
| FAMILY : TEREDINIDAE | | | |
| *Bactronophorus thoracites* (Gould ) | + | + | Benthos |
| *Bankia campanellata* Moll & Roch | + | + | Benthos |
| *Bankia nordi* Moll | + | + | Benthos |
| *Bankia rochi* Moll | + | + | Benthos |
| *Dicyathifer manni* (Wright) | + | + | Benthos |
| *Nausitora dunlopei* Wright | + | - | Benthos |
| ORDER : MYOIDA | | | |
| FAMILY : LATERNULIDAE | | | |
| *Laternula truncata* (Lamarck) | + | - | Benthos |
| CLASS : CEPHALOPODA, Squids and Octopuses | | | |
| ORDER : DECAPODA | | | |
| FAMILY : SEPIDAE | | | |
| *Sepia aculeata* F. | + | + | Pelagic |
| *Sepiella inermis* F. | + | + | Pelagic |
| FAMILY : LOLIGINIDAE | | | |
| *Loligo indica* Pfeiffer | + | + | Pelagic |
| ORDER : OCTOPODA | | | |
| FAMILY : OCTOPODIDAE | | | |
| *Octopus rugosus* (Bosc) | + | + | Pelagic |
| PHYLUM : ANNELIDA, Segmented worms | | | |
| CLASS : POLYCHAETA, Bristle worms | | | |
| FAMILY : POLYNOIDAE | | | |
| *Lepidonotus tenuisetosus* (Gravier) | + | + | Benthos |
| FAMILY : PHYLLODOCIDAE | | | |
| *Phyllodoce madeirensis* Langerhans | | + | Benthos |
| *Eteone barantollae* Fauvel | | + | Benthos |
| FAMILY : PILARGIDAE | | | |
| *Ancistrosyllis constricta* Southern | + | | Benthos |
| *Talehsapia annandalei* Fauvel | + | + | Benthos |
| FAMILY : NEREIDAE | | | |
| *Dendronereides heteropoda* Southern | | | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Dendronereis arborifera* Peters | + | + | Benthos |
| *Dendronereis aestuarina* Southern | + | + | Benthos |
| *Namalycastis indica* (Southern) | + | + | Benthos |
| *Lycastonereis indica* Rao | - | + | Benthos |
| *Neanthes chingrighattensis* Fauvel | - | + | Benthos |
| *Neanthes cricognatha* Ehlers | + | + | Benthos |
| *Perinereis nigropunctata* Horst | + | + | Benthos |
| FAMILY : GLYCERIDAE | | | |
| *Glycera alba* (Müller) | + | + | Benthos |
| *Glycera lancadive* Schmarda | - | + | Benthos |
| *Glycera rouxi* Audouin & Milne Edwards | - | + | Benthos |
| *Goniada emerita* Audouin & Milne Edwards | - | + | Benthos |
| FAMILY : EUNICIDAE | | | |
| *Eunice aphroditois* (Pallas) | - | + | Benthos |
| *Lysidice collaris* Grube | - | + | Benthos |
| *Marphysa mossambica* (Peters) | - | + | Benthos |
| *Maphysa macintoshi* Crossland | - | + | Benthos |
| *Marphysa sanguinea* (Montagu) | - | + | Benthos |
| FAMILY : ONUPHIDAE | | | |
| *Diopatra cuprea* (Bosc) | + | + | Benthos |
| *Diopatra neopolitana* Delle Chiaje | + | + | Benthos |
| FAMILY : LUMBRINERIDAE | | | |
| *Lumbrineris heteropoda* Marenzeller | + | + | Benthos |
| *Lumbrineris notocirrata* (Fauvel) | + | + | Benthos |
| *Lumbrineris polydesma* (Southern) | + | + | Benthos |
| FAMILY : SPIONIDAE | | | |
| *Polydora kempi* Southern | - | + | Benthos |
| *Prionospio cirrifera* Wiren | - | + | Benthos |
| *Spio bengalensis* Willey | - | + | Benthos |
| FAMILY : CAPITELLIDAE | | | |
| *Heteromastus similis* (Southern) | - | + | Benthos |
| *Mastobranchus indicus* Southern | - | + | Benthos |
| FAMILY : STERNASPIDAE | | | |
| *Stenaspis scutata* (Ranzani) | - | + | Benthos |
| FAMILY : SABELLARIDAE | | | |
| *Sabellaria pectinata* var *intermedia* Fauvel | - | + | Benthos |
| FAMILY : SABELLIDAE | | | |
| *Laonome indica* Southern | - | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : APHRODITIDAE | | | |
| *Gattyana deludens* Fauvel | - | + | Benthos |
| FAMILY : NEPHTYIDAE | | | |
| *Nephtys oligobranchia* Southern | | + | Benthos |
| FAMILY : TEREBELLIDAE | | | |
| *Loimia medusa* (Savigny) | | + | Benthos |
| CLASS : OLIGOCHAETA, Earthworms | | | |
| *Pontodrilus bermudansis* Beddard | + | | Behthos |
| *Metaphire posthuma* (Vaillant) | | + | Benthos |
| *Eutyphoeus orientalis* (Beddart) | | + | Benthos |
| *Polypheretima elongata* (Perrier) | | + | Benthos |
| *Perionyx excavatus* Perrier | | + | Benthos |
| *Lamplto mauritti* Kinlerg | | | |
| CLASS : HIRUDINEA, Leeches | | | |
| FAMILY : ICHTHYOBELLIDAE | | | |
| *Pontobdella aculeata* Harding | - | + | Epibenthos |
| FAMILY : GLOSSIPHONIDAE | | | |
| *Glossiphonia weberi* R. Blanchard | - | + | Epibenthos |
| *Helobdella nociva* Harding | | + | Epibenthos |
| PHYLUM : ECHIURIDA | | | |
| *Anelassorhyrnchus branchiorhynchus* (Annandale & Kemp) | + | + | Soil dwellers |
| *Anelassorhynchus dendrorhynchus* (Annandale & Kemp) | + | + | " |
| PHYLUM : SIPUNCULA | | | |
| *Phascolosoma arcuatum* (Gray) | + | + | " |
| PHYLUM : ARTHROPODA | | | |
| CLASS : CRUSTACEA | | | |
| SUBCLASS : BRANCHIOPODA | | | |
| FAMILY : ANOSTRACA | | | |
| *Artemia salina* L. | + | + | Plankton |
| ORDER : CLADOCERA, Water fleas | | | |
| *Bosminspris* sp. | | + | Plankton |
| *Evadre* sp. | | + | Plankton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| SUBCLASS : COPEPODA | | | |
| *Acartiella keralensis* | + | + | Plankton |
| *Acartiella sewelli* | + | + | Plankton |
| *Acartia spinicauda* | + | + | Plankton |
| *Neodiaptomus strigilipes* | + | + | Plankton |
| *Pseudodiaptomus binghami* | + | + | Plankton |
| *Pseudodiaptomus annandalei* | + | + | Plankton |
| *Pseudodiaptomus tollingeri* | + | + | Plankton |
| *Pseusodiaptomus masoni* | + | + | Plankton |
| *Pseudodiaptomus daughlishi* | + | + | Plankton |
| *Pseudodiaptomus hickmani* | + | + | Plankton |
| *Halicyclops tenuispina* | + | + | Plankton |
| *Labidocera euchaeta* | + | + | Plankton |
| *Labidocera minuta* | + | + | Plankton |
| *Pontonella andersoni* | + | + | Plankton |
| *Eucalanus subcrassus* | + | + | Plankton |
| *Eucalanus elongatus* | + | + | Plankton |
| *Euchaeta marina* | + | + | Plankton |
| *Euchaeta wolfendeni* | + | + | Plankton |
| *Euchaeta concinna* | + | + | Plankton |
| *Euchaeta tenuis* | + | + | Plankton |
| *Centropages fuscatus* | + | + | Plankton |
| *Temora turbinata* | + | + | Plankton |
| *Temora discaudata* | + | + | Plankton |
| *Tortarus gracilis* | + | + | Plankton |
| *Tortanus forcipatus* | + | + | Plankton |
| *Candacia bradyi* | + | + | Plankton |
| *Canthocalanus pauper* | + | + | Plankton |
| *Undinula darwini* | + | + | Plankton |
| *Corycaeus catus* | + | + | Plankton |
| *Corycaeus agilis* | + | + | Plankton |
| *Corycaeus danae* | + | + | Plankton |
| *Oncaea venusata* | + | + | Plankton |
| *Tachidius discipes* | + | + | Plankton |
| *Cyclops kuckarti* Claus | + | + | Plankton |
| *Mesocyclops* sp. | + | + | Plankton |
| *Paracalanus* spp. | + | + | Plankton |
| *Acrocalanus* spp. | + | + | Plankton |
| *Laophonte* spp. | + | + | Plankton |
| *Harpacticus* sp. | + | + | Plankton |
| *Euterpina acutifrons* | + | + | Plankton |
| *Cladorostrata brevipoda* | + | + | Plankton |
| *Clytemestra scutellata* | + | + | Plankton |
| *Macrosetella gracilis* | + | + | Plankton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| SUBCLASS : OSTRACODA | | | |
| *Philomedes* sp. | + | + | Plankton |
| SUBCLASS : BRANCHIURA | | | |
| *Argulus foliaceus* | + | + | Parasitic |
| SUBCLASS : CIRRIPEDIA<br>ORDER : THORACICA<br>FAMILY : LEPADIDAE | | | |
| *Lepas anserifera* Linn. | + | + | Sedentary |
| FAMILY : TRILASMATIDAE | | | |
| *Octolasmis orthogonia* (Darwin) | + | + | Sedentary |
| *Octolasmis warwickii* Gray | + | + | Sedentary |
| *Octolasmis cor* (Aurivillius) | + | + | Sedentary |
| FAMILY : CHTHAMALIDAE | | | |
| *Chthamalus withersi* Pilsbry | + | + | Sedentary |
| *Chthamalus malayensis* Pilsbry | + | + | Sedentary |
| FAMILY : BALANIDAE | | | |
| *Balanus tintinnabulus* (Linn.) | + | + | Sedentary |
| *Balanus amphitrite variegatus* Darwin | + | + | Sedentary |
| *Balanus amphitrite cirratus* Darwin | + | + | Sedentary |
| *Balanus amaryllis* Darwin | + | + | Sedentary |
| *Balanus patellaris* (Spengler) | + | + | Sedentary |
| *Chelonibia testudinaria* (Linn.) | + | + | Sedentary |
| *Megabalanus tintinnabulum* (Linn.) | + | + | Sedentary |
| *Europlia withersi* (Pilsbry) | + | + | Sedentary |
| *Conchoderms virgatum hasteri* (Owen) | + | + | Sedentary |
| SUBCLASS : MALACOSTRACA<br>ORDER : MYSIDACEA | | | |
| *Mesopodopsis orientalis* L. | + | + | Pelagic |
| ORDER : CUMACEA | | | |
| *Paradiatylis* spp. | + | + | Pelagic |
| ORDER : ISOPODA | | | |
| *Cymothoa indica* Schioedte & Meinert | + | + | Parasitic |
| *Nerocilla madrassensis* Ramkrishna and Venkata Ramaniah | + | + | Parasitic |
| *Epipenaeon elegans* Chopra | + | + | Parasitic |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Palaegyge prashadi* Chopra | + | + | Parasitic |
| *Palaegyge buitendijki* Horst | + | + | Parasitic |
| *Palaegyge alcocki* Chopra | + | + | Parasitic |
| *Palaegyge abhoyai* Chopra | + | + | Parasitic |
| *Palaegyge bengalensis* Chopra | + | + | Parasitic |
| *Palaegyge brachysoma* Chopra | + | + | Parasitic |
| *Probopyrus gangeticus* Chopra | + | + | Parasitic |
| *Bopyrus squillarum* var. *bimaculatus* Chopra | + | + | Parasitic |
| *Sphaeroma* sp. | + | + | Plant Parasitic |
| ORDER : AMPHIPODA, Beach fleas, Scuds,etc. | | | |
| FAMILY : GAMMARIDAE | | | |
| *Eriopisa chilkansis* Stebbing | + | + | Pelagic |
| *Quadrivisio bengalensis* Stebbing | + | + | Pelagic |
| ORDER : STOMATOPODA | | | |
| *Squilla latreillei* (Eydoux and Souleyet) | + | + | Pelagic |
| *Squilla scorpio* var. *immaculata* Kemp | + | + | Pelagic |
| *Squilla nipa* Latreille | + | + | Pelagic |
| *Squilla holoschista* Kemp | + | + | Pelagic |
| *Squilla oratoria* var. *inornata* Tate | + | + | Pelagic |
| *Squilla interrupta* Kemp | + | + | Pelagic |
| *Squilla wood-masoni* Kemp | + | + | Pelagic |
| *Squilla raphidea* Fabricius | + | + | Pelagic |
| *Squilla decorata* (Wood-Mason) | + | + | Pelagic |
| *Squilla gilesi* Kemp | + | + | Pelagic |
| *Squilla annandeli* Kemp | + | + | Pelagic |
| *Lysiosquilla maculata* Miers | + | + | Pelagic |
| *Lysiosquilla acanthocarpus* Miers | + | + | Pelagic |
| ORDER : DECAPODA | | | |
| SUBORDER : MACRURA | | | |
| FAMILY : PALAEMONIDAE | | | |
| *Palaemon styliferus* Milne-Edw. | + | + | Pelagic |
| *Palaemon tenuipes* (Henderson) | + | + | Pelagic |
| *Macrobrachium javanicum* (Heller) | + | + | Pelagic |
| *Macrobrachium lamarrei* (Milne-Edw.) | + | + | Pelagic |
| *Macrobrachium malcomsonii* (Milne-Edw.) | + | + | Pelagic |
| *Macrobrachium mirabile* Kemp | + | + | Pelagic |
| *Macrobrachium rosenbergii* (de Man) | + | + | Pelagic |
| *Macrobrachium rude* (Heller) | + | + | Pelagic |
| *Macrobrachium scabriculum* (Heller) | + | + | Pelagic |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : PENAEIDAE | | | |
| *Metapenaeus affinis* (Milne-Edw.) | + | + | Pelagic |
| *Metapenaeus brevicornis* (Milne-Edw.) | + | + | Pelagic |
| *Metapenaeus lysianasa* (de-Man) | + | + | Pelagic |
| *Metapenaeus monoceros* (Fabricius) | + | + | Pelagic |
| *Parapenaeopsis sculptilis* (Heller) | + | + | Pelagic |
| *Parapenaeopsis stylifera* (Milne-Edw.) | + | + | Pelagic |
| *Parapenaeus longipes* Alcock | + | + | Pelagic |
| *Penaeus indicus* Milne-Edw. | + | + | Pelagic |
| *Penaeus monodon* Fabricius | + | + | Pelagic |
| FAMILY : SERGESTIDAE | | | |
| *Acetes indicus* Milne-Edw. | + | + | Pelagic |
| *Acetes erythraeus* Nobili | + | + | Pelagic |
| *Lucifer hanseni* Nobili | + | + | Pelagic |
| FAMILY : ALPHEIDAE | | | |
| *Alphaeus paludicola* Kemp | + | + | Pelagic |
| SUBORDER : ANOMURA | | | |
| FAMILY : DIOGENIDAE | | | |
| *Clibanarius padavensis* de Man | + | - | Benthos |
| *Diogenes avarus* Heller | + | - | Benthos |
| FAMILY : COENOBITIDAE | | | |
| *Coenobita cavipes* Stimpson | | | Benthos |
| SUBORDER : BRACHYURA | | | |
| FAMILY : GRAPSIDAE | | | |
| *Sesarma bidens* (de Haan) | + | + | Benthos |
| *Sesarma impressa* (Milne-Edw.) | + | + | Benthos |
| *Sesarma tetragonum* Fabricius | + | + | Benthos |
| *Sesarma taeniolatum* White | + | + | Benthos |
| *Sesarma edwardsi* de Man | + | + | Benthos |
| *Sesarma pictum* de Haan | + | + | Benthos |
| *Sesarma longibes* Krauss | + | + | Benthos |
| *Metopograpsus messor* (Forskal) | + | + | Benthos |
| *Metopograpsus maculatus* Edwards | + | + | Benthos |
| *Metaplax dentipes* (Heller) | + | + | Benthos |
| *Metaplax intermedia* de Man | + | + | Benthos |
| *Metaplax crenulata* Gerstaecker | + | + | Benthos |
| *Metaplax indica* Edwards | + | + | Benthos |
| *Varuna litterata* (Fabricius) | + | + | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : MAIIDAE | | | |
| *Doclea japonica* Ortman | + | - | Benthos |
| *Doclea canalifera* Stimpson | + | + | Benthos |
| *Doclea tetraptera* A.O. Walker | + | + | Benthos |
| FAMILY : LEUCOSIIDAE | | | |
| *Leucosia caniolaris* (Herbst) | + | + | Benthos |
| *Philyra globosa* Fabr. | + | + | Benthos |
| *Philyra globulosa* Edw. | + | + | Benthos |
| *Arcania septemspinosa* (Fabr.) | + | + | Benthos |
| *Arcania crinaceus* (Fabr.) | + | + | Benthos |
| FAMILY : DORIPPIDAE | | | |
| *Dorippe facchino* (Herbst) | + | + | Benthos |
| *Ethusa indica* Alcock | + | + | Benthos |
| FAMILY : DROMIIDAE | | | |
| *Conchoecetes artificiosus* (Fabr.) | + | + | Benthos |
| FAMILY : PALICIDAE | | | |
| *Typhlocarcinus nudus* Stimpson | + | + | Benthos |
| FAMILY : HYMENOSOMIDAE | | | |
| *Hymenicus woodmasonia* Alcock | + | + | Benthos |
| *Hymenicus inaechoides* Alcock | + | + | Benthos |
| FAMILY : XANTHIDAE | | | |
| *Euricarcinus grandidieri* Milne-Edw. | + | - | Pelagic |
| FAMILY : CALAPPIDAE | | | |
| *Calappa lophos* (Herbst) | + | - | Pelagic |
| *Matuta victor* Gabricius | + | - | Pelagic |
| *Matuta planipes* Fabricius | + | - | Pelagic |
| *Matuta lunaris* (Herbst) | + | - | Pelagic |
| FAMILY : PORTUNIDAE | | | |
| *Scylla serrata* (Forskal) | + | + | Pelagic |
| *Portunus pelagicus* (Linn.) | + | + | Pelagic |
| *Portunus sanguinolentus* (Linn.) | + | + | Pelagic |
| *Charybdis orientalis* (Herbse) | + | + | Pelagic |
| *Charybdis rostata* A. Milne-Edw. | + | + | Pelagic |
| *Charybdis ornata* A. Milne-Edw. | + | + | Pelagic |
| *Charybdis merginensis* de Man | + | + | Pelagic |
| *Charybdis cruciata* de Man | + | + | Pelagic |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : OCYPODIDAE | | | |
| *Ocypode macrocera* A. Milne-Edw. | + | - | Benthos |
| *Uca acuta* (Stimpson) | + | + | Benthos |
| *Uca dussumieri* (Milne-Edw.) | + | + | Benthos |
| *Uca annulipes* (H. Milne-Edw.) | + | + | Benthos |
| *Uca triangularis* Nobili | + | + | Benthos |
| *Dotilla blanfordi* Alcock | + | + | Benthos |
| *Dotillopsis brevitarsis* (de Man) | + | + | Benthos |
| *Illyoplax gangeticus* (Kemp) | + | + | Benthos |
| *Macrophthalmus pectinipes* Guerin | + | + | Benthos |
| *Macrophthalmus teschi* Kemp | + | + | Benthos |
| *Scopimera globosa* de Haan | + | + | Benthos |
| CLASS : INSECTA<br>SUBCLASS : PTERYGOTA<br>ORDER : ORTHOPTERA<br>FAMILY : PYRGOMORPHIDAE | | | |
| *Chrotogonus tr. trachypterus* (Blanchard) | + | + | Ground dwellers |
| *Atractomorpha crenulata* (Fabricius) | + | + | Ground dwellers |
| FAMILY : ACRIDIDAE | | | |
| *Gesonula punctifrons* (Staol) | + | + | Ground dwellers |
| *Oxya fuscovittata* (Marshall) | + | + | Ground dwellers |
| *Oxya hyla hyla* Serville | + | + | Ground dwellers |
| *Oxya nitidula* (Walker) | + | + | Ground dwellers |
| *Eyprepoenemis alacris alacris* (Serville) | + | + | Ground dwellers |
| *Trilophidia annulata* (Thunb.) | + | + | Ground dwellers |
| *Acrida exaltata* (Walker) | + | + | Ground dwellers |
| *Spathosternum prasiniferum prasiniferum* (Walker) | + | + | Ground dwellers |
| *Leva indica* Bolvar | + | + | Ground dwellers |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Aiolopus thalassinus tamulus* (Fabr.) | + | + | Ground dwellers |
| ORDER : DERMAPTERA | | | |
| FAMILY : PYGIDICRANIDAE | | | |
| *Paradiplatys gladiator* (Burr) | + | + | Ground dwellers |
| *Cranopygia picta* (Guerin-Mineville) | + | + | Ground dwellers |
| FAMILY : CARCINOPHORIDAE | | | |
| *Euborellia stali* (Dohrn) | + | + | Ground dwellers |
| FAMILY : LABIDURIDAE | | | |
| *Nala lividipes* (Dufour) | + | + | Ground dwellers |
| *Labidura riparia* (Pallas) | + | + | Ground dwellers |
| *Forcipula quadrispinosa* (Dohrn) | + | + | Ground dwellers |
| FAMILY : CHELISOCHIDAE | | | |
| *Proreus simulans abdominalis* Ramamurthi | + | + | Ground dwellers |
| ORDER : ISOPTERA | | | |
| FAMILY : KALOTERMITIDAE | | | |
| *Cryptotermes dudleyi* Banks | + | + | Wood dwellers |
| *Cryptotermes havilandi* (Sjostedt) | + | + | Wood dwellers |
| FAMILY : RHINOTERMITIDAE | | | |
| *Heterotermes indicola* (Wasmann) | - | + | Wood and soil dweller |
| *Coptotermes heimi* (Wasmann) | - | + | Wood and soil dweller |
| FAMILY : TERMITIDAE | | | |
| *Microcerotermes beesoni* Snyder | + | + | Wood and soil dweller |
| *Microcerotermes cameroni* Snyder | + | + | Wood and soil dweller |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Odontotermis redemanii* (Wasmann) | - | + | Soil dweller |
| ORDER : ODONATA | | | |
| SUBORDER : ZYGOPTERA | | | |
| FAMILY : COENAGRIONIDAE | | | |
| *Ceriagrion coromandelianum* (Fabr.) | - | + | |
| *Ceriagrion cerinorubellum* (Brauer) | - | + | |
| *Pseudagrion decorum* (Rambur) | + | + | |
| *Pseudagrion australasiae* (Rambur) | - | + | |
| *Ischnura senegalensis* Rambur | - | + | |
| *Ischnura aurora* Brauer | - | + | |
| *Cercion malayanum* Selys | - | + | |
| *Agriocnemis pygmaea pygmaea* (Rambur) | - | + | |
| *Onychargia atrocyana* Selys | - | + | |
| SUBORDER : ANISOPTERA | | | |
| FAMILY : MACRODIPLACTIDAE | | | |
| *Urothemis signata signata* (Rambur) | + | + | |
| *Macrodiplax cora* (Brauer) | | | |
| FAMILY : LIBELLULIDAE | | | |
| *Lathrecista asiatica asiatica* (Fabr.) | + | + | |
| *Orthetrum safina safina* (Drury) | + | + | |
| *Brachydiplax sobrina* (Rambur) | + | + | |
| *Acisoma panorpoides panorpoides* Rambur | + | + | |
| *Diplacodes trivialis* (Rambur) | + | - | |
| *Crocothemis servilia servilia* (Drury) | + | - | |
| *Bradinopyga geminata* (Rumbur) | + | + | |
| *Neurothemis tullia tullia* (Drury) | + | + | |
| *Neurothemis fulvia* (Drury) | + | + | |
| *Brachythemis contaminata* (Fabr.) | + | + | |
| *Trithemis pallidinervis* (Kerby) | + | + | |
| *Tholymis tillarga* (Fabr.) | + | + | |
| *Pantala flavescens* (Babr.) | + | + | |
| *Tramea virginia* (De geer) | + | + | |
| ORDER : NEUROPTERA | | | |
| FAMILY : CHRYSOPIDAE | | | |
| *Chrysoperla orestes* (Banks) | + | + | |
| *Anisochrysa alcestes* (Banks) | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : MANTISPIDAE | | | |
| *Mantispa femoralis* Banks | + | + | |
| *Mantispa indica* Westwood | + | + | |
| FAMILY : HEMEROBIIDAE | | | |
| *Psectra iniqua* (Hagen) | + | + | |
| ORDER : LEPIDOPTERA | | | |
| FAMILY : DANAIDAE | | | |
| *Danaus melanippus indicus* (Fruhstorfer) | + | + | |
| FAMILY : PAPILIONIDAE | | | |
| *Atrophaneura hector* (Linn.) | + | + | |
| *Giraphium nomius swinhoei* (Moore) | + | + | |
| FAMILY : PIERIDAE | | | |
| *Catopsilia crocale crocale* (Cramer) | + | + | |
| *Eurema brigitta rubella* (Wallace) | + | + | |
| SUBORDER : HETEROCERA | | | |
| FAMILY : SPHINGIDAE | | | |
| *Hippotion celerio* (Linn.) | + | + | |
| FAMILY : LYMANTRIIDAE | | | |
| *Euproctis* sp. | + | + | |
| FAMILY : NOCTUIDAE | | | |
| *Polydesma inangulata* (Guenee) | + | + | |
| *Ophiusa coronata* (Fabricius) | + | + | |
| ORDER : COLEOPTERA | | | |
| FAMILY : CARABIDAE | | | |
| *Pheropsophus cotorei* Dej. | + | + | |
| *Slenolophus* sp. | + | + | |
| *Zuphium* sp. | + | + | |
| *Harpalus* sp. | + | + | |
| FAMILY : CICINDELIDAE | | | |
| *Cicindela erudata* Wiedmann | + | + | |
| *Cicindela biromasa* F. | + | + | |
| *Cicindela quadrilineata* F. | + | + | |
| FAMILY : HALIPLIDAE | | | |
| *Haliplus* sp. | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : HYDROPHILIDAE | + | + | |
| *Sternolophus rufipes* (F). | + | + | |
| *Berosus* sp. | + | + | |
| *Enocrus* sp. | + | + | |
| FAMILY : STAPHYLINIDAE | | | |
| *Charichirus* sp. | + | + | |
| FAMILY : SCARABAEIDAE | | | |
| *Heteronychus lioderes* Redtenbacher | + | + | |
| *Adoretus lacustris* Arrow | + | + | |
| *Adoretus* sp. | + | + | |
| *Heliocopris gigas* (L.) | + | + | |
| *Onthophagus quadridentalus* (F.) | + | + | |
| FAMILY : HETEROCERIDAE | | | |
| *Heterocerus* sp. | + | + | |
| FAMILY : BOSTRYCHIDAE | | | |
| *Rhizopertha dominica* (Fab.) | + | + | |
| *Heterobostrichus aequalis* Wat. | + | + | |
| *Dinoderus* sp. | + | + | |
| FAMILY : SILVANIDAE | | | |
| *Monanus concinnulus* (Walker) | + | + | |
| *Oryzaephilus mercator* (Fauvel) | + | + | |
| FAMILY : TENEBRIONIDAE | | | |
| *Ceropria* sp. | + | + | |
| *Alphitobius diaperinus* (Panz.) | + | + | |
| FAMILY : INOPEPLIDAE | | | |
| *Inopeplus* sp. | + | + | |
| FAMILY : CERAMBYCIDAE | | | |
| *Xystrocera globosa* Oliv. | + | + | |
| FAMILY : CHRYSOMELIDAE | | | |
| *Dactylispa armigera* (Fabr.) | + | + | |
| FAMILY : BRUCHIDAE | | | |
| *Callosobruchus* sp. | + | + | |
| FAMILY : CURCULIONIDAE | | | |
| *Tanymecus albomarginatus* Gyl. | + | + | |
| *Sitophilus* sp. | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : HYMENOPTERA | | | |
| FAMILY : ICHNEUMONIDAE | | | |
| *Menoforia indica* Gupta & Saxena | - | + | |
| *Enicospilus nocturnus* (Kohl) | - | + | |
| FAMILY : APIDAE (Bees) | | | |
| *Apis (= Megapis) dorsata* Fabr. | + | + | |
| *Apis (= Micropis) florea* Fabr. | + | + | |
| FAMILY : VESPIDAE (Wasps) | | | |
| *Vespa cineta* Fabr. | + | + | |
| *Polistis hebraeus* Fabr. | + | + | |
| FAMILY : FORMICIDAE | | | |
| *Camponotus compresus* Fabr. | + | + | |
| *Sima rufonigra* Jerdon | + | + | |
| *Solenopsis gemineta* Fabr. | + | + | |
| *Monomorium indicum* Fabr. | + | + | |
| ORDER : DIPTERA | | | |
| FAMILY : TIPULIDAE | | | |
| *Geranomyia cercipuractata* Brun. | - | + | |
| *Geranomyia flavicosta* Brun. | - | + | |
| *Geranomyia tridens* Brun. | - | + | |
| *Mongamioides trentepohlii* Wied. | - | + | |
| FAMILY : PSYCHODIDAE | | | |
| *Psychoda bengalensis* Brun. | - | + | |
| FAMILY . PHLEBOTOMIDAE | | | |
| *Phlebotomus argentipes* Ann. & Brun. | - | + | |
| *Phlebotomus bengalensis* Brun. | - | + | |
| *Phleobotomus minutus* Rond. | - | + | |
| FAMILY : CULICIDAE | | | |
| *Aedes niveus* (Ludlow) | + | - | |
| *Anopheles subpictus* Grassi | + | + | |
| *Anopheles sundaicus* (Roden Waldt) | + | + | |
| *Aedeomyia catastica* Knab | + | + | |
| *Culex vishnui* Theob. | + | + | |
| *Lutzia fuscans* Wied. | + | + | |
| *Taeniorhynchus annuliferus* Theob. | + | + | |
| *Taeniorhynchus uniformis* Theob. | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : CERATOPOGONIDAE | | | |
| *Culicoides oxystoma* Theob. | + | + | |
| *Cuculoides* spp. | + | + | |
| FAMILY : PHORIDAE | | | |
| *Megaselia scalaris* Theob. | + | + | |
| FAMILY : CHIRONOMIDAE | | | |
| *Chironomus* spp. | + | + | |
| FAMILY : STRATIOMYIDAE | | | |
| *Odontomyia rubrithorax* Macq. | + | + | |
| *Odontomyia dorsoangulata* Burn. | + | + | |
| FAMILY : TABANIDAE | | | |
| *Chrysops dispar* Fabr. | - | + | |
| *Haematopota javana* Wied. | + | + | |
| *Tabanus striatus* Fabr. | + | + | |
| *Atylotus agrestis* Fabr. | + | + | |
| FAMILY : EMPIDIDAE | | | |
| *Elaphropeza ferruginea* Brun. | + | + | |
| FAMILY : DOLICHOPODIDAE | | | |
| *Medeterus grisescens* de May | + | + | |
| FAMILY : PIPUNCULIDAE | | | |
| *Pipunculus biroi* Kert. | | + | |
| FAMILY : SYRPHIDAE | | | |
| *Helophilus quadrivittatus* Wied. | | + | |
| *Syritta orientalis* Macq. | | + | |
| *Syritta rufifacies* Big. | - | + | |
| *Eristalis obscuritarsis* Mey. | | + | |
| FAMILY : SEPSIDAE | | | |
| *Sepsis indica* Wied. | - | + | |
| FAMILY : SARCOPHAGIDAE | | | |
| *Sarcophaga dux* Thoms. | | + | |
| *Sarcophaga ruficornis* Fab. | - | + | |
| FAMILY : MUSCIDAE | | | |
| *Curicea pumila* Wied. | | + | |
| *Cyrtoneura stobulans* Fll. | | + | |
| *Lipsa pumila* Wied. | - | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Musca crassirostris* Stein. | - | + | |
| *Musca pattoni* Aust. | - | + | |
| *Musca seniorwhite* Patton | - | + | |
| *Musca vicina* Macq. | - | + | |
| *Stomoxys calcitrans* Linn. | + | + | |
| *Stomoxys indica* Pic. | + | + | |
| *Orthellia indica* Linn. | - | + | |
| CLASS : ARACHNIDA<br>ORDER : XIPHOSURA | | | |
| *Tachypleus gigas* (Linn.) | + | - | |
| *Carcinoscorpius rotundicauda* (Latreille) | + | - | |
| ORDER : ARANEAE<br>FAMILY : HYCOSIDAE | | | |
| *Lycosa* sp. | + | + | Ground/ Arboreal |
| FAMILY : CLUBIONIDAE | | | |
| *Clubiona* sp. | + | + | Ground/ Arboreal |
| *Cheiracanthium* sp. | + | + | Ground/ Arboreal |
| *Castianeria* sp. | + | + | Ground/ Arboreal |
| FAMILY : OXYOPIDAE | | | |
| *Oxyopis* sp. | + | + | Ground/ Arboreal |
| *Peucia* sp. | - | + | Ground/ Arboreal |
| FAMILY : PESAURIIDAE | | | |
| *Nephila maculata* Pocock | + | + | Ground/ Arboreal |
| ORDER : ACARINA<br>FAMILY : ERIOPHYIDAE | | | |
| *Bakeriella ocimis* Chakraborty & Mandal | + | + | Soil inhabitants |
| *Eriophyes pongamiae* (Channabasavanna) | + | + | Soil inhabitants |
| *Aculops abutiloni* Mandal & Chakraborty | + | + | Soil inhabitants |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : PHTHIRACARIDAE | | | |
| *Hoplophorella sundarbanensis* Sanyal and Bhaduri | + | + | Soil inhabitants |
| FAMILY : EUPHTHIRACARIDAE | | | |
| *Rhysotritia ardua* (Koch) var. *otaheitensis* Hammer | + | + | Soil inhabitants |
| FAMILY : COSMOCHTHONIIDAE | | | |
| *Trichthonius heterotrichus* Sanyal and Bhanduri | + | + | Soil inhabitants |
| FAMILY : HAPLOCHTHONIIDAE | | | |
| *Haplochthonius intermedius* Chakraborti, Bhaduri and Raychaudhuri | + | + | Soil inhabitants |
| FAMILY : OPPIIDAE | | | |
| *Brachioppia ananthakrishni* Sanyal and Bhaduri | + | + | Soil inhabitants |
| *Multioppia simplitricha* Sanyal and Bhaduri | + | + | Soil inhabitants |
| *Oppia orientalis* Sanyal and Bhaduri | + | + | Soil inhabitants |
| *Oppia ramisetosa* Sanyal and Bhaduri | + | + | Soil inhabitants |
| FAMILY : PHYTOSEIIDAE | | | |
| *Amblyseius (Amblyseius) largoensis* (Muma) | + | + | On plants |
| *A. (Euseius) ovalis* (Evans) | + | + | On plants |
| *A. (E.) finlandicus* (Oudemans) | + | + | On plants |
| *A. (E.) coccineae* Gupta | + | + | On plants |
| *A. (Typhlodromips) suknaensis* Gupta | + | + | On plants |
| FAMILY : TETRANYCHIDAE | | | |
| *Aponychus corpuzae* Rimando | + | + | |
| *Eutetranychus orientalis* (Klein) | + | + | |
| *Tetranychus cinnabarinus* (Boisduval) | + | + | |
| *Oligonychus mangiferus* (Rahman & Sapra) | + | - | |
| *Eotetranychus* sp. | | | |
| FAMILY : STIGMAEIDAE | | | |
| *Agistemus fleschneri* Summers | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : TYDEIDAE | | | |
| *Tydeius* sp. | + | + | |
| *Parapronematus* sp. | + | + | |
| FAMILY : EUPODIDAE | | | |
| *Eupodes* sp. | + | + | |
| FAMILY : CUNAXIDAE | | | |
| *Cunaxa* sp. | + | + | |
| PHYLUM : ECHINODERMATA, Spiny - skinned animals | | | |
| CLASS : STELLEROIDEA | | | |
| SUBCLASS : ASTEROIDEA, Sea stars | | | |
| ORDER : PAXILLOSIDA | | | |
| FAMILY : ASTROPECTINIDAE | | | |
| *Astropecten euryacanthus* Luetken | + | + | Benthos |
| SUBCLASS : OPHIUROIDEA, Brittle stars | | | |
| ORDER : OPHIUROIDA | | | |
| FAMILY : AMPHIURIDAE | | | |
| *Amphioplus hastatus* (Ljungman) | + | - | Benthos |
| *Amphioplus laeois* (Lyman) | + | - | Benthos |
| FAMILY : OPHIACTIDAE | | | |
| *Ophiactis delagoa* Balinsky | + | - | Benthos |
| *Ophiactis modesta* Brock | + | - | Benthos |
| FAMILY : OPHIOTRICHIDAE | | | |
| *Ophiocnemis marmorata* (Lamarck) | + | - | Benthos |
| CLASS : ECHINOIDEA, Sea urchins etc. | | | |
| ORDER : TEMNOPLEUROIDA | | | |
| FAMILY : TEMNOPLEURIDAE | | | |
| *Temnopleurus toreumaticus* (Leske) | + | - | Benthos |
| ORDER : CLYPEASTEROIDA | | | |
| FAMILY : CLYPEASTERIDAE | | | |
| *Clypeaster rarispinus* de Meijere | + | - | Benthos |
| FAMILY : LAGANIDAE | | | |
| *Laganum decagonale* (de Blainville) | + | - | Benthos |
| FAMILY : ASTRICLYPEIDAE | | | |
| *Echinodiscus auritus* (Leske) | + | - | Benthos |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| CLASS: HOLOTHUROIDEA, Sea cucumbers | | | |
| ORDER : DENDROCHIROTIDA | | | |
| FAMILY : CUCUMARIIDAE | | | |
| *Stolus rapax* (Kochler & Vaney) | + | - | Benthos |
| *Thorsonia investigatoris* (Kochler & Vaney) | + | - | Benthos |
| ORDER : MOLPADIIDA | | | |
| FAMILY : CAUDINIDAE | | | |
| *Acaudina molpadioides* (Semper) | + | + | Benthos |
| *Paracaudina australis* (Semper) | + | + | Benthos |
| PHYLUM : HEMICHORDATA, Acorn worms | | | |
| CLASS : ENTEROPNEUSTA | | | |
| •FAMILY : HARRIMANIIDAE | | | |
| *Saccoglossus* sp. | + | + | Benthos |
| PHYLUM : CHORDATA | | | |
| CLASS : CHONDRICHTHYES | | | |
| ORDER : LAMNIFORMES | | | |
| FAMILY : ORECTOLOBIDAE, Tiger shark | | | |
| *Chilloscyllum griseum* Muller & Henle | + | + | Nekton |
| *Stegostoma fasciatum* (Herman) | + | + | Nekton |
| FAMILY : CARCHARHINIDAE, Sharks & Hammerheaded sharks | | | |
| *Carcharhinus limbatus* (Valenciennes) | + | + | Nekton |
| *Carcharhinus melanopterus* (Quoy & Gaimard) | + | + | Nekton |
| *Glyphis gangeticus* (Muller & Henle) | + | + | Nekton |
| FAMILY : SPHYRNIDAE | | | |
| *Sphyrna blochii* (Cuvier) | + | + | Nekton |
| ORDER : RAJIFORMES | | | |
| FAMILY : PRISTIDAE, Saw-fish | | | |
| *Pristis microdon* Latham | + | + | Nekton |
| FAMILY : RHINOBATIDAE, Guitar-fish | | | |
| *Rhinobatos annandalei* Norman | + | + | Nekton |
| FAMILY : TORPEDINIDAE, Electric-rays | | | |
| *Narcine brunnea* Annandale | + | + | Nekton |
| FAMILY : DASYATIDAE | | | |
| *Dasyatis (Amphotistius) zagei* (Muller & Henle) | + | + | Nekton |
| *Dasyatis (Himantura) bieekeri* (Blyth) | + | + | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Dasyatis (Himantura) marginatus* (Blyth) | + | + | Nekton |
| *Dasyatis (Himantura) uarnak* (Forsskal) | + | + | Nekton |
| *Dasyatis (Pastinachus) sephen* (Forsskal) | + | + | Nekton |
| FAMILY : MYLIOBATIDAE, Eagle-rays. | | | |
| *Aetobatus narinari* (Euphrasen) | + | + | Nekton |
| CLASS : OSTEICHTHYES<br>ORDER : CLUPEIFORMES<br>FAMILY : CLUPEIDAE | | | |
| *Corica soborna* Hamilton - Buchanan | - | + | Nekton |
| *Gadusia chapra* (Hamilton-Buchanan) | - | + | Nekton |
| *Hilsa (Tenualosa) ilisha* (Hamilton-Buchanan) | + | + | Nekton |
| *Anodontostoma chacunda* (Hamilton-Buchanan) | | | |
| *Anodonstoma thailandiae* Wongratana | + | - | Nekton |
| *Gonialosa manmina* (Hamilton-Buchanan) | + | - | Nekton |
| *Nematalosa nasus* (Bloch) | + | - | Nekton |
| *Ilisha elongata* (Bennett) | + | + | Nekton |
| *Pellona ditchela* Valenciennes | + | - | Nekton |
| *Raconda russeliana* Gray | + | - | Nekton |
| FAMILY : ENGRAULIDAE | | | |
| *Coilia dussumieri* Valenciennes | + | + | Nekton |
| *Coilia neglecta* Whitehead | + | + | Nekton |
| *Coilia ramcarati* (Hamilton-Buchanan) | + | + | Nekton |
| *Coilia raynaldi* Valenciennes | + | + | Nekton |
| *Setipinna phasa* (Hamilton-Buchanan) | + | + | Nekton |
| *Setipinna taty* (Valenciennes) | | | |
| *Thryssa hamiltoni* (Gray) | + | + | Nekton |
| *Thryssa purava* (Hamilton-Buchanan) | + | + | Nekton |
| ORDER : ELOPIFORMES<br>FAMILY : MEGALOPIDAE | | | |
| *Megalops cyprinoides* (Broussouet) | + | + | Nekton |
| ORDER : ANGUILLIFORMES<br>FAMILY : ANGUILLIDAE | | | |
| *Anguilla bengalensis bengalensis* (Gray) | + | + | Nekton |
| FAMILY : MORINGUANIDAE | | | |
| *Moringua raitaborua* (Hamilton-Buchanan) | - | + | Nekton |
| FAMILY : MURAENIDAE | | | |
| *Lycodontis sathete* (Hamilton-Buchanan) | - | + | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Lycodontis tile* (Hamilton-Buchanan) | - | + | Nekton |
| FAMILY : MURAENESOCIDAE | | | |
| *Muraenesox bagio* (Hamilton-Buchanan) | + | - | Nekton |
| *Muraenesox cinereus* (Forsskal) | + | - | Nekton |
| FAMILY : OPHICHTHYIDAE | | | |
| *Pisoodonophis boro* (Hamilton-Buchanan) | + | + | Nekton |
| ORDER : GONORYNCHIFORMES | | | |
| FAMILY : CHANIDAE | | | |
| *Chanos chanos* (Forsskal) | + | + | Nekton |
| ORDER : SILURIFORMES | | | |
| FAMILY : BAGRIDAE | | | |
| *Aorichthys aor* (Hamilton-Buchanan) | + | + | Nekton |
| *Mystus cavasius* (Hamilton-Buchanan) | + | + | Nekton |
| *Mystus gulio* (Hamilton-Buchanan) | + | + | Nekton |
| *Mystus vittatus* (Bloch) | + | + | Nekton |
| FAMILY : SCHILBEIDAE | | | |
| *Silonia silondia* (Hamilton-Buchanan) | - | + | Nekton |
| FAMILY : PANGASIIDAE | | | |
| *Pangasius pangasius* (Hamilton-Buchanan) | + | + | Nekton |
| FAMILY : ARIIDAE | | | |
| *Arius sona* (Hamilton-Buchanan) | - | + | Nekton |
| *Arius arius* (Hamilton-Buchanan) | + | + | Nekton |
| *Arius gagora* (Hamilton-Buchanan) | + | + | Nekton |
| *Arius caelatus* Valenciennes | + | + | Nekton |
| *Arius jella* Day | - | + | Nekton |
| *Arius platystomus* Day | + | - | Nekton |
| *Hemipimelodus jatius* | - | + | Nekton |
| *Osteogeniosus militaris* (Linn.) | + | - | Nekton |
| FAMILY : PLOTOSIDAE | | | |
| *Plotosus canius* (Hamilton-Buchanan) | + | - | Nekton |
| FAMILY : HARPADONTIDAE | | | |
| *Harpadon nehereus* (Hamilton-Buchanan) | + | + | Nekton |
| ORDER : BATRACHOIDIFORMES | | | |
| FAMILY : BATRACHOIDAE | | | |
| *Batrichthys grunniens* (Linn.) | + | - | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : ATHERIFORMES | | | |
| FAMILY : HEMIRAMPHIDAE | | | |
| *Rhynchorhamphus georgii* (Valenciennes) | + | - | Nekton |
| *Zenarchopterus brachyopterus* (Bleeker) | + | - | Nekton |
| *Zenarchopterus striga* (Blyth) | + | - | Nekton |
| FAMILY : BELONIDAE | | | |
| *Strongylura leiura* (Bleeker) | + | + | Nekton |
| *Strongylura strongylura* (Van Haseelt) | + | + | Nekton |
| *Xenontodon cancila* (Hamilton-Buchanan) | - | + | Nekton |
| FAMILY : CYPRINODONTIDAE | | | |
| *Oryzias melanostigma* (McClelland) | + | - | Nekton |
| *Aplocheilus panchax* (Hamilton) | + | - | Nekton |
| ORDER : SYNBRANCHIFORMES | | | |
| FAMILY : SYNBRANCHIDAE | | | |
| *Monopterus cuchia* (Hamilton) | + | - | Nekton |
| ORDER : PERCIFORMES | | | |
| FAMILY : CENTROPOMIDAE | | | |
| *Lates calcarifer* (Bloch) | + | + | Nekton |
| FAMILY : AMBASSIDAE | | | |
| *Chanda nama* Hamilton | + | + | Nekton |
| *Parambassis baculis* (Hamilton) | + | + | Nekton |
| *Parambassis ranga* (Hamilton) | + | + | Nekton |
| FAMILY : TERAPONIDAE | | | |
| *Terapon jarbura* (Forsskal) | + | + | Nekton |
| FAMILY : SILLAGINIDAE | | | |
| *Sillaginopsis panijus* (Hamilton) | + | + | Nekton |
| *Sillago sihama* (Forsskal) | + | + | Nekton |
| FAMILY : CARANGIDAE | | | |
| *Caranx carangus* (Bloch) | - | + | Nekton |
| *Megalaspis cordyla* (Linn.) | - | + | Nekton |
| FAMILY : LEIOGNATHIDAE | | | |
| *Leiognathus blochii* (Valencienness) | + | + | Nekton |
| *Leiognathus equulus* (Forsskal) | + | + | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| FAMILY : LUTJANIDAE | | | |
| *Lutjanus argentimaculatus* (Forsskal) | + | + | Nekton |
| *Lutjanus johni* (Bloch) | + | + | Nekton |
| FAMILY : LOBOTIDAE | | | |
| *Datnioides quadrifasciatus* (Sevastianov) | + | + | Nekton |
| FAMILY : GERRIDAE | | | |
| *Gerres oyena* (Forsskal) | + | + | Nekton |
| *Gerreomorpha setifer* (Hamilton) | + | + | Nekton |
| FAMILY : POMADASYIDAE | | | |
| *Pomadasys argenteus* (Forsskal) | + | + | Nekton |
| *Pomadasys nasta* (Bloch) | + | + | Nekton |
| FAMILY : SCIAENIDAE | | | |
| *Daysciaena albida* (Cuvier) | + | + | Nekton |
| *Johnius belangeri* (Cuvier) | + | + | Nekton |
| *Johnius coitor* (Hamilton) | + | + | Nekton |
| *Johnius sina* (Cuvier) | + | + | Nekton |
| *Johnius vogleri* (Bleeker) | + | + | Nekton |
| *Nibea soldado* (Lacepede) | + | + | Nekton |
| *Otolithoides biauritus* (Cantor) | + | + | Nekton |
| *Pama pama* (Hamilton) | + | + | Nekton |
| FAMILY : EPHIPPIDAE | | | |
| *Drepane punctata* (Linn.) | + | + | Nekton |
| FAMILY : SCATOPHAGIDAE | | | |
| *Scatophagus argus* (Linn.) | + | + | Nekton |
| FAMILY : NANDIDAE | | | |
| *Nandus naudus* (Hamilton) | - | + | Nekton |
| FAMILY : CICHLIDAE | | | |
| *Etroplus suratensis* (Bloch) | | | |
| FAMILY : MUGILIDAE | | | |
| *Liza microlepis* (Smith) | + | + | Nekton |
| *Liza parsia* (Hamilton) | + | + | Nekton |
| *Liza subviridis* (Valenciennes) | + | + | Nekton |
| *Liza tade* (Forsskal) | + | + | Nekton |
| *Mugil cephalus* Linn. | + | + | Nekton |
| *Rhinomugil corsula* (Hamilton) | + | + | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Valamugil cunnesius* (Valenciennes) | + | + | Nekton |
| *Valamugil speigleri* (Bleeker) | + | + | Nekton |
| FAMILY : POLYNEMIDAE | | | |
| *Eleutheronema tetradactylum* (Shaw) | + | + | Nekton |
| *Polydactylus indicus* (Shaw) | + | + | Nekton |
| *Polynemus paradiseus* Linn. | + | + | Nekton |
| FAMILY : GOBIIDAE | | | |
| *Apocryptes bato* (Hamilton) | + | + | Nekton |
| *Awaouichthys menoni* Chatterjee | + | + | Nekton |
| *Boleophthalmus boddaerti* (Valenciennes) | + | + | Nekton |
| *Brachygobius nanus* (Hamilton) | + | + | Nekton |
| *Glossogobius giuris* (Hamilton) | - | + | Nekton |
| *Gobiopterus chuno* (Hamilton) | - | + | Nekton |
| *Periophthalmodon schlosseri* (Valenciennes) | + | + | Nekton |
| *Periophthalmus koelreuteri* (Pallas) | + | + | Nekton |
| *Periophthalmus pearsei* Eggert | | | |
| *Pseudapocryptes lanceolatus* (Bloch & Schneider) | + | + | Nekton |
| *Scartelaos histophorus* (Valenciennes) | - | + | Nekton |
| FAMILY : GOBIOIDIDAE | | | |
| *Odontamblypus rubicundus* (Hamilton) | + | + | Nekton |
| FAMILY : TRYPAUCHENIDAE | | | |
| *Amblyotrypauchen arctocephalus* (Alcock) | + | + | Nekton |
| *Trypauchen vagina* (Bloch & Schneider) | + | + | Nekton |
| FAMILY : KURTIDAE | | | |
| *Kurtus indicus* Bloch | + | - | Nekton |
| FAMILY : TRICHIURIDAE | | | |
| *Enpleurogrammus muticus* (Gray) | + | - | Nekton |
| *Lepturacanthus pantulai* (Gupta) | + | + | Nekton |
| *Lepturacanthus savala* (Cuvier) | + | + | Nekton |
| *Trichiurus gangeticus* Gupta | + | + | Nekton |
| FAMILY : STROMATEIDAE | | | |
| *Pampus argenteus* (Euphrasen) | + | - | Nekton |
| *Pampus chinensis* (Euphrasen) | + | - | Nekton |
| *Stromateus sinensis* Day | + | - | Nekton |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : PLEURONECTIFORMES | | | |
| FAMILY : SOLEIDAE | | | |
| *Euryglossa pan* (Hamilton) | + | - | Nekton |
| FAMILY : CYNOGLOSSIDAE | | | |
| *Cynoglossus cynoglossus* (Hamilton) | + | + | Nekton |
| *Cynoglossus lingua* (Hamilton) | + | + | Nekton |
| ORDER : TETRAODONTIFORMES | | | |
| FAMILY : TRIACANTHIDAE | | | |
| *Triacanthus brevirostris* Temminck & Schlegel | + | - | Nekton |
| FAMILY : TETRAODONTIDAE | | | |
| *Chelonodon cutcutia* (Hamilton) | + | - | Nekton |
| *Chelonodon patoca* (Hamilton) | + | - | Nekton |
| *Fugu oblongus* (Bloch) | + | - | Nekton |
| *Lagocephalus lunaris* (Temminck & Schlegel) | + | - | Nekton |
| CLASS : AMPHIBIA | | | |
| ORDER : ANURA | | | |
| FAMILY : BUFONIDAE, Toads | | | |
| *Bufo melanostictus* Schneider, Common Toad | - | + | Terrestrial |
| FAMILY : RANIDAE, Frog | | | |
| *Rana cyanophlyctis* Schneider, Skipper Frog | - | + | Amphibious |
| *Rana limnocharis* Wiegmann, Cricket Frog | - | + | Amphibious |
| *Rana tigerina* Daudin, Indian Bull Frog | - | + | Amphibious |
| *Rana hexadactyla* Lesson, Pond/Green Frog | - | + | Amphibious |
| FAMILY : RHACOPHORIDAE, Tree Frogs | | | |
| *Rhacophorus maculatus* (Gray), Tree Frog | + | + | Arboreal |
| FAMILY : MICROHYLIDAE | | | |
| *Microhyla ornata* Dumeril & Bibron, Ornate Microhylid | - | + | Terrestrial |
| CLASS : REPTILIA | | | |
| ORDER : CHELONIA | | | |
| FAMILY : EMYDIDAE, Freshwater tortoises or Terrapirs | | | |
| *Batagur baska* (Gray) Common Batagur | + | + | Aquatic |
| *Geomyda tricarinata* Blyth, Three-keeled Terrapin | + | + | Aquatic |
| *Kachuga kachuga* (Gray) | + | + | Aquatic |
| *Kachuga tecta* Tentbridge | + | + | Aquatic |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Geoclemys hamiltoni* (Gray) | + | + | Aquatic |
| *Morenia ocellata* (Dum. & Bib.), | + | + | Aquatic |
| FAMILY : TRIONYCHIDAE, Freshwater Turtles | | | |
| *Trionyx gangeticus* Cuvier | - | + | Aquatic |
| *Trionyx hurum* Gray | + | + | Aquatic |
| *Lissemys punctata* (Bonnaterre) | - | + | Aquatic |
| *Pelochelys bibroni* (Owen) | + | + | Aquatic |
| *Chitra indica* (Gray) | + | - | Aquatic |
| FAMILY : CHELONIDAE, Marine Turtles | | | |
| *Lepidochelys olivacea* (Eschscholtz) | + | - | Aquatic |
| ORDER : SQUAMATA | | | |
| SUBORDER : LACERTILIA | | | |
| FAMILY : GEKKONIDAE | | | |
| *Gekko gecko* (Linn.) | - | + | Arboreal |
| *Hemidactylus brooki* Gray | - | + | Terrestrial |
| *Hemidactylus flaviviridis* Rupell | - | + | Terrestrial |
| *Hemidactylus leschenaulti* Dumeril and Bibron | - | + | Terrestrial |
| FAMILY : AGAMIDAE | | | |
| *Calotes versicolor* (Daudin) | - | + | Terrestrial |
| FAMILY : CHAMAELEONTIDAE | | | |
| *Chamaeleon zeylanicus* Laurenti, Indian Chamaeleon | - | + | Terrestrial |
| FAMILY : SCINCIDAE | | | |
| *Mabuya carinata* (Schneider) | - | + | Terrestrial |
| *Mabuya dissimilis* (Hallowell) | - | + | Terrestrial |
| *Riopa albopunctata* Gray | - | + | Terrestrial |
| FAMILY : VARANIDAE, Varanus | | | |
| *Varanus bengalensis* (Daudin) | - | + | Terrestrial |
| *Varanus salvator* (Laurenti) | + | + | Terrestrial |
| *Varanus flavescens* (Gray) | - | + | Terrestrial |
| SUBORDER : OPHIDIA | | | |
| FAMILY : TYPHLOPIDAE, Blind snakes | | | |
| *Typhlops porrectus* Stoliczka | - | + | Terrestrial |
| *Typhlops braminus* (Daudin) | - | + | Terrestrial |
| FAMILY : BOIDAE, Pythons, Boas | | | |
| *Python molurus* Linnaeus, Indian Python | + | - | Terrestrial |
| *Eryx conicus* (Schneider), Russell's Sand Boa. | - | + | Terrestrial |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Acrochordus granulatus* Schneider, Thinket Snake | + | + | Aquatic |
| *Elaphe helena* (Daudin) | + | + | Terrestrial |
| *Ptyas mucosus* Linnaeus, Rat Snake | - | + | Terrestrial |
| *Oligodon arnensis* Shaw | | | |
| *Ahaetulla nasutus* (Lacepede), Green whip Snake | - | + | Terrestrial |
| *Ahaetulla myctarijans* (Linnaeus) | - | + | Terrestrial |
| *Lycodon aulicus* Linnaeus, Common wolf Snake | + | + | Terrestrial |
| *Natrix stolata* Linnaeus, Checkered Keelback | - | + | Terrestrial |
| *Atretium schistosum* Daudin, Olivaceous Keelback | - | + | Terrestrial |
| *Enhydris enhydris* Schneider | - | + | Aquatic |
| *Cerberus rhynchops* Schneider | - | + | Aquatic |
| *Gerardia frevostiana* Eydoux & Gervais | - | + | Terrestrial |
| *Dendrelaphis ahaetulla* (Linnaeus) | - | + | Terrestrial |
| *Dendrelaphis tristis* Daudin | - | + | Terrestrial |
| FAMILY : ELAPIDAE | | | |
| *Bungarus caeruleus* Schneider, Common Indian Krait | + | + | Terrestrial |
| *Bungarus fasciatus* Schneider, Banded Krait | + | + | Terrestrial |
| *Naja naja* Linnaeus Common Cobra | + | + | Terrestrial |
| *Ophiophagus hannah* (Cantor), King Cobra | - | + | Terrestrial |
| FAMILY : HYDROPHIDAE | | | |
| *Praescutata viperina* Schmidt | + | + | Aquatic |
| *Enhydrina schistosa* Daudin | + | + | Aquatic |
| *Hydrophis nigrocinctus* Daudin | + | + | Aquatic |
| *Hydrophis obscurus* Daudin | + | + | Aquatic |
| *Hydrophis caerulescens* shaw | + | + | Aquatic |
| *Microcephalophis gracilis* Shaw | + | + | Aquatic |
| *Microcephalophis cantoris* Gunther | + | + | Aquatic |
| FAMILY : VIPERIDAE | | | |
| *Vipera russelli* Shaw, Russell's Viper | - | + | Terrestrial |
| *Trimeresurus erythrurus* Cantor, Pit Viper | - | + | Terrestrial |
| ORDER : CROCODILIA | | | |
| *Crocodylus porosus* Schneider, Estuarine Crocodile | + | - | Aquatic |
| CLASS : AVES | | | |
| A. Resident Species | | | |
| ORDER : PODICIPEDIFORMES | | | |
| FAMILY : PODICEPIDIDAE, Grebes | | | |
| *Podiceps ruficollis* (Pallas), Dabchick | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : CICONIFORMES | | | |
| FAMILY : ARDEIDAE, Herons, Egrets | | | |
| *Ardea cinerea* (Linn.), Grey Heron | + | + | |
| *Ardea purpurea* (Linn.), Purple Heron | + | + | |
| *Egretta alba* Linn., Large Egret | + | + | |
| *Ardeola grayi* (Sykes), Pond Heron | + | + | |
| *Ardeola striatus* (Linnaeus), Little Green Heron | + | + | |
| *Bubulcus ibis* (Linn.), Cattle Egret | + | + | |
| *Egretta intermedia* (Wagler), Smaller Egret | + | + | |
| *Egretta grazetta* (Linn.), Little Egret | + | + | |
| *Nycticorax nycticorax* (Linn.), Night Heron | + | + | |
| *Ixobrychus minutus* (Linn.), Little Bittern | + | + | |
| *Ixobrychus cinnamomeus* (Gmelin), Chestnut Bittern | + | + | |
| *Ixobrychus flavicollis* (Latham), Black Bittern | + | + | |
| *Anastomus oscitans* (Boddaert), Openbilled Stork | + | + | |
| *Threskiornis melanocephala* (Latham), White Ibis | + | + | |
| *Leptoptilos dubius* (Gmelin), Adjutant Stork | + | + | |
| *Xenorhynchus asiaticus* (Latham), Blacknecked Stork | + | + | |
| ORDER : PELECANIFORMES | | | |
| FAMILY : ANHINGIDAE, Darters | | | |
| *Anhinga rufa* (Daudin), Darter | + | + | |
| ORDER : ANSERIFORMES | | | |
| FAMILY : ANATIDAE, Ducks, Geese, Swans | | | |
| *Nettapus coromandelianus* (Gmelin), Cotton Teal | + | + | |
| ORDER : FALCONIFORMES | | | |
| FAMILY : ACCIPITRIDAE, Hawks | | | |
| *Milvus migrans* (Boddaert), Pariah Kite | + | + | |
| *Haliastur indus* (Boddaert), Brahminy Kite | + | + | |
| *Haliaeetus leucogaster* (Gmelin), Whitebellied Sea Eagle | + | + | |
| *Spilornis cheela* (Latham), Crested Serpent Eagle | + | + | |
| *Icthyophaga ichthyaetus* (Horsfield), Greyheaded Fishing Eagle | + | + | |
| *Haliaeetus leucoryphus* (Pallas), Pallas's Fishing Eagle | + | + | |
| *Accipiter badius* (Gmelin), Shikra | + | + | |
| *Gyps bengalensis* (Gmelin), Whitebacked Vulture | - | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : GALLIFORMES | | | |
| FAMILY : PHASIANIDAE, Pheasants, Quails | | | |
| *Francolinus gularis* (Temminck), Swamp Partridge | + | - | |
| *Gallus gallus* Linn., Red Jungle Fowl | + | - | |
| ORDER : PELICANIFORMES | | | |
| FAMILY : PHALACROCORACIDAE, Cormorants | | | |
| *Phalacrocorax niger* (Vieillot), Little Cormorant | + | + | |
| ORDER : COLUMBIFORMES | | | |
| FAMILY : COLUMBIDAE, Doves, Pigeons | | | |
| *Treron phoenicoptera* (Latham), Green Pigeon | + | + | |
| *Streptopelia decaocto* (Frivaldszky), Ring Dove | + | + | |
| *Streptopelia chinensis* (Scopoli), Spotted Dove | + | + | |
| ORDER : PSITTACIFORMES | | | |
| FAMILY : PSITTACIDAE, Parrots, | | | |
| *Psittacula krameri* (Scopoli), Roseringed Parakeet | + | + | |
| ORDER : CUCULIFORMES | | | |
| FAMILY : CUCULIDAE | | | |
| *Eudynamys scolopacea* (Linn.), Koel | - | + | |
| *Clamator jacobinus* (Boddaert), Piedcrested Cuckoo | + | + | |
| *Cuculus varius* (Vahl), Brainfever Bird | + | + | |
| *Cuculus micropterus* Gould, Indian Cuckoo | + | + | |
| *Centropus sinensis* (Stephens), Crow Pheasant | + | + | |
| ORDER : STIGIFORMES | | | |
| FAMILY : STRIGIDAE, Owls | | | |
| *Tyto alba* (Scopoli), Barn Owl | + | + | |
| *Otus scops* (Linn.), Scops Owl | + | + | |
| *Otus bakkamoena* Pennant, Collared Scops Owl | + | + | |
| *Bubo zeylonensis* (Gmelin), Brown Fish Owl | + | + | |
| *Bubo bubo* (Linn.), Eagle Owl | + | + | |
| *Athene brama* (Temminck), Spotted Owlet | + | + | |
| ORDER : CAPRIMULGIFORMES | | | |
| FAMILY : CAPRIMULGIDAE, Nightjars | | | |
| *Caprimulgus indicus* Latham, Jungle Nightjar | | | |
| ORDER : APODIFORMES | | | |
| FAMILY : APODIDAE, Swifts | | | |
| *Cypsiurus parvus* (Lichtenstein), Palm Swift | - | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : CORACIFORMES | | | |
| FAMILY : CORACIIDAE, Rollers | | | |
| *Coracias benghalensis* (Linn.), Indian Roller | + | + | |
| FAMILY : ALCEDINIDAE, Kingfishers | | | |
| *Alcedo atthis* (Linn.), Common Kingfisher | + | + | |
| *Pelargopsis amauroptera* (Pearson), Brownwinged Kingfisher | + | + | |
| *Halcyon pileata* (Boddaert), Blackcapped Kingfisher | + | + | |
| *Halcyon smyrnensis* (Linn.), Whitebreasted Kingfisher | + | + | |
| *Halcyon chloris* (Boddaert), Whitecollared Kingfisher | + | + | |
| *Ceryle rudis* (Linn.), Lesser Pied Kingfisher | + | + | |
| FAMILY : MEROPIDAE, Bee-eaters | | | |
| *Merops orientalis* Latham, Green Bee-eater | - | + | |
| FAMILY : UPUPIDAE, Hoopoe | | | |
| *Upupa epops* Linn., Hoope | + | + | |
| ORDER : PICIFORMES | | | |
| FAMILY : CAPITONIDAE, Barbets | | | |
| *Megalaima haemacephala* (Muller), Coppersmith | - | + | |
| FAMILY : PICIDAE, Woodpeckers | | | |
| *Micropternus brachyurus* (Vieillot), Rufous Woodpecker | + | + | |
| *Dinopium benghalense* (Linn.), Lesser Goldenbacked Woodpecker | + | + | |
| *Chrysocolaptes lucidus* (Scopoli), Larger Goldenbacked Woodpecker | + | + | |
| ORDER CHARADRIFORMES | | | |
| FAMILY : JACANIDAE | | | |
| *Metopidius indicus* (Latham), Bronzewinged Jacana | + | + | |
| *Hydrophasianus chirurgus* (Scopoli), Pheasanttailed Jacana | + | + | |
| FAMILY : CHARADRIIDAE, Plovers | | | |
| *Vanellus indicus* (Boddaert), Redwattled Lapwing. | + | + | |
| *Charadrius dubius* Scopoli, Little Ringed Plover | + | + | |
| FAMILY : ROSTRATULIDAE, Painted Snipe | | | |
| *Rostratula benghalensis* (Linn.), Painted Snipe | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : GRUIFORMES | | | |
| FAMILY : LARIDAE, Gulls, Terns | | | |
| *Rynchops albicollis* (Swainson) | + | + | |
| *Sterna albiforns* (Pallas), Little Tern | + | + | |
| *Sterna acuticauda* J.E. Gray, Blackbilled Tern | + | + | |
| *Sterna bergii* (Lichtenstein), Largecrested Tern | + | + | |
| *Sterna bengalensis* (Lesson), Indian Lessercrested Tern | + | + | |
| *Sterna aurantia* J.E. Gray, Indian River Tern | + | + | |
| FAMILY : RALLIDAE, Rails | | | |
| *Amaurornis phoenicurus* (Pennant), Whitebreasted Waterhen | + | + | |
| *Porphyrio porphyrio* (Linn.), Purple Moorhen | + | + | |
| *Gallinula chloropus* (Linn.), Moorhen. | + | + | |
| *Fulica atra* (Linn.), Coot | + | + | |
| PASSERIFORMES | | | |
| FAMILY : ALAUDIDAE, Larks | | | |
| *Alauda gulgula* Franklin, Eastern Skylark | - | + | |
| FAMILY : LANIIDAE, Shrikes | | | |
| *Lanius schach* Linn., Blackheaded Shrike | + | + | |
| FAMILY : ORIOLIDAE, Orioles | | | |
| *Oriolus xanthornus* (Linn.), Blackheaded Oriole | - | + | |
| FAMILY : DICRURIDAE, Drongoes | | | |
| *Dicrurus adsimilis* (Bechstein), Black Drongo | + | + | |
| FAMILY : ARTAMIDAE, Wood Swallows | | | |
| *Artamus fuscus* (Vieillot), Ashy Swallow Shrike | - | + | |
| FAMILY : STURNIDAE, Starlings | | | |
| *Sturnus malabaricus* (Gmelin), Greyheaded Myna | - | + | |
| *Sturnus contra* Linn., Pied Myna. | + | + | |
| *Acridotheres tristis* (Linn.), Common Myna. | - | + | |
| *Acridotheres ginginianus* (Latham), Bank Myna | - | + | |
| *Acridotheres fuscus* (Wagler), Jungle Myna | + | + | |
| FAMILY : CORVIDAE, Crows, Jays | | | |
| *Dendrocitta vagabunda* (Latham), Tree Pie | - | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Corvus splendens* Vieillot, House Crow | - | + | |
| *Corvus macrorhynchos* Wagler, Jungle Crow | + | + | |
| FAMILY : PYCNONOTIDAE, Bulbuls | | | |
| *Pycnonotus jocosus* (Linn.), Redwhiskered Bulbul | - | + | |
| *Pycnonotus cafer* (Linn.), Redvented Bulbul | - | + | |
| FAMILY : TIMALIIDAE, Babblers | | | |
| *Turdoides striatus* (Dumont), Jungle Babbler | - | + | |
| FAMILY : MUSCICAPIDAE, Old World Flycatchers | | | |
| *Muscicapa parva* Bechstein, Redbreasted Flycatcher | + | + | |
| *Terpsiphone paradisi* Linn., Paradise Flycatcher | + | + | |
| *Pachycephela grisola* (Blyth), Mangrove Whistler | + | + | |
| FAMILY : SYLVIIDAE, Old World Warblers | | | |
| *Orthotomus sutorius* (Pennant), Tailor Bird | + | + | |
| *Acrocephalus dumetorum* Blyth, Blyth's Read Warbler | - | + | |
| *Phylloscopus fuscatus* (Blyth), Dusky Leaf Warbler | - | + | |
| *Phylloscopus collybita* (Vieillot), Chiffchaff. | - | + | |
| *Acrocephalus agericola* (Jerdon), Paddy-field Warbler | - | + | |
| FAMILY : TURDIDAE, Thrushes | | | |
| *Copsychus saularis* (Linn.), Magpie Robin. | - | + | |
| *Saxicola caprata* (Linn.), Pied Bushchat | - | + | |
| FAMILY : PARIDAE, Tits | | | |
| *Parus major* Linn., Grey Tit | + | + | |
| FAMILY : DICAEDAE, Flowerpeckers | | | |
| *Dicaeum erythrorhynchus* (Latham), Tickell's Flowerpecker | - | + | |
| FAMILY : NECTARINIDAE, Sunbirds | | | |
| *Nectarinia zeylonica* (Linn.), Purplerumped Sunbird | - | + | |
| *Nectarinia asiatica* (Latham), Purple Sunbird | - | + | |
| FAMILY : ZOSTEROPIDAE, White-eyes | | | |
| *Zosterops palpebrosa* (Temminck), White-eye | - | + | |
| FAMILY : PLOCEIDAE, Weaver birds | | | |
| *Passer domesticus* (Linn.), House Sparrow, | - | + | |
| *Ploceus philippinus* (Linn.), Baya | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Lonchura striata* (Linn.), Whitebacked Munia. | - | + | |
| *Lonchura punctulata* (Linn.), Spotted Munia | - | + | |
| B. Migratory Species | | | |
| ORDER : CICONIFORMES | | | |
| FAMILY : ARDEIDAE, Herons, Egrets, | | | |
| *Ardea goliath* Cretzschman, Giant Heron | + | + | |
| ORDER : PELECANIFORMES | | | |
| FAMILY : PELECANIDAE, Pelicans | | | |
| *Pelecanus philippensis* Gmelin, Spotted-billed Pelecan | + | - | |
| ORDER : ANSERIFORMES | | | |
| FAMILY : ANATIDAE, Ducks, Swans, Geese, | | | |
| *Aythya ferina* (Linn.), Common Pochard. | + | - | |
| *Anas crecca* Linn., Common Teal, | + | + | |
| *Anas acuta* (Linn.), Pintail | + | + | |
| *Anas strepera* Linn., Gadwall | + | + | |
| *Aythya nyroca* (Guldenstadt), White-eyed Pochard | + | + | |
| *Tadorna ferruginea* (Pallas), Brahminy Duck | + | + | |
| *Aythya marila* (Linnaeus), Scaup Duck | + | - | |
| *Dendrocygna javanica* (Horsfield), Lesser Whistling Teal | + | + | |
| *Netta rufina* (Pallas), Redcrested Pochard | + | + | |
| ORDER : FALCONIFORMES | | | |
| FAMILY : FALCONIDAE, Falcons | | | |
| *Falco tinnunculus* Linn., Kestrel | + | + | |
| *Falco peregrinus* Tunstall, Peregrine Falcon | + | + | |
| FAMILY : ACCIPITRIDAE HAWKS | | | |
| *Pandion haliaetus* (Linn.), Osprey | + | + | |
| *Circus aeruginosus* (Linn.), Marsh Harrier | + | - | |
| ORDER : GRUIFORMES | | | |
| FAMILY : LARIDAE, Gulls, Terns | | | |
| *Larus argentatus* (Pontoppidan), Herring Gull | + | + | |
| *Larus ridibundus* (Linn.), Blackheaded Gull | + | + | |
| *Larus brunnicephalus* (Jerdon), Brownheaded Gull | + | + | |
| *Hydroprogne caspia* (Pallas), Caspian Tern | + | + | |
| *Sterna hirundo* (Linn.), Common Tern | | | |
| *Sterna fuscata* (Linn.), Sooty Tern | | | |
| *Gelochelidon nilotica* (Gmelin), Gullbilled Tern | + | + | |
| *Chlidonias hybrida* (Pallas), Whiskered Tern | + | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : CHARADRIIFORMES | | | |
| FAMILY : CHARADRIIDAE, Plovers | | | |
| *Vanellus cinereus* (Blyth), Greyheaded Lapwing | - | + | |
| *Calidris tenuirostris* (Horsfield), Eastern Knot, | + | + | |
| *Calidris minuta* (Leisler), Little Stint | + | + | |
| *Calidris testacea* (Pallas), Curlew-Sandpiper | + | + | |
| *Charadrius dubius* Scopoli, Little Ringed Plover | + | + | |
| *Lemnodronus semipalmatus* (Blyth), Snipebilled Godwit | + | + | |
| *Calidris alpinus* (Linn.), Dunlin | + | - | |
| *Arenaria interpres* (Linn.), Turnstone | + | - | |
| FAMILY : SCOLOPACIDAE, Sandpipers | | | |
| *Numenius phaeopus* (Linn.), Whimbrel | + | - | |
| *Numenius arquata* (Linn.), Curlew | + | + | |
| *Limosa limosa* (Linn.), Blacktailed Godwit | + | - | |
| *Tringa totanus* (Linn.), Common Red Shank | + | + | |
| *Tringa glareola* (Linn.), Wood Sandpiper | + | + | |
| *Tringa terek* (Latham), Terek Sandpiper | + | + | |
| *Tringa ochropus* Linnaeus, Green Sandpiper | + | - | |
| *Tringa hypoleucos* Linn., Common Sandpiper | + | + | |
| *Gallinago gallinago* (Linn.), Fantail Snipe | + | + | |
| *Gallinago stenura* (Bonaparte), Pintail Snipe | + | + | |
| *Tringa nebularia* (Gunner), Green Shank | + | + | |
| ORDER : COLUMBIFORMES | | | |
| FAMILY : COLUMBIDAE, Doves, Pigeons | | | |
| *Streptopelia orientalis* (Latham), Rufoustailed Dove | + | + | |
| ORDER : PICIFORMES | | | |
| FAMILY : PICIDAE, Woodpeckers | | | |
| *Jynx torquilla* Linn., Wryneck | + | + | |
| FAMILY : HIRUNDINIDAE, Swallows | | | |
| *Hirundo rustica* Linn., Common Swallow | | | |
| ORDER : PASSERIFORMES | | | |
| FAMILY : TURDIDAE, Thrushes | | | |
| *Phoenicurus ochruros* (Gmelin), Black Redstart | + | + | |
| *Saxicola torquata* (Linn.), Collard Bush Chat | + | + | |
| *Monticola solitarius* (Linn.), Blue Rock Thrush | + | + | |
| *Erithacus svecicus* (Linn.), Blue Throat | + | + | |
| FAMILY : MOTACILLIDAE, Wagtails | | | |
| *Motacilla alba* Linn., White Wagtail | - | + | |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Motacilla citreola* (Pallas), Yellowheaded Wagtail | - | + | |
| *Anthus novaeseelandiae* (Gmelin), Paddy Field Pipit | - | + | |
| *Anthus hodgsoni* Richmond, Indian Tree Pipit | - | + | |
| CLASS MAMMALIA | | | |
| ORDER : INSECTIVORA | | | |
| FAMILY : SORICIDAE, Shrews | | | |
| *Suncus murinus* (Linn.), House Shrew or Grey Musk Shrew | - | + | Found in burrows |
| ORDER : CHIROPTERA | | | |
| FAMILY: PTEROPIDAE, Fruit Bats or Flying Foxes | | | |
| *Pteropus giganteus* (Brunnich), Indian Flying Fox | - | + | On trees |
| *Cynopterus sphinx* (Vahl) | - | + | |
| FAMILY : VESPERTILIONIDAE | | | |
| *Pipistrellus mimus* (Wroughton), Indian Pygmy Pipistrelle | - | + | Casual visitors |
| *Scotophilus kuhli* Leach, Lesser Yellow Bat | - | + | Casual visitors |
| FAMILY : MEGADERMATIDAE | | | |
| *Megaderma lyra* (Geoffroy), Indian False Vampire | - | + | Casual visitors |
| *Megaderma spasma* Linn. | + | - | Found in old temple |
| FAMILY : RHINOPOMATIDAE | | | |
| *Rhinopoma hardwickii* Gray, Lesser Rattailed Bat | - | + | Casual visitor |
| *Hipposideros bicolor* Temminck, Bicoloured Leaf-nosed Bat | - | + | Casual visitor |
| *Hipposideros lankadiva* Kelaart, Cave Bat | + | + | Residential |
| FAMILY : EMBALLONURIDAE | | | |
| *Taphozous longimanus* Hardwicke | - | + | Residential |
| *Rhinolophus lepidus* Blyth | - | + | Residential |
| ORDER : PRIMATE | | | |
| FAMILY : CERCOPITHECIDAE | | | |
| *Macaca mulatta* (Zimmermann.), Rhesus Monkey | + | - | On trees |
| ORDER : PHOLIDOTA | | | |
| *Manis pentadactyla* Linn., Pangolin | + | - | In burrows |

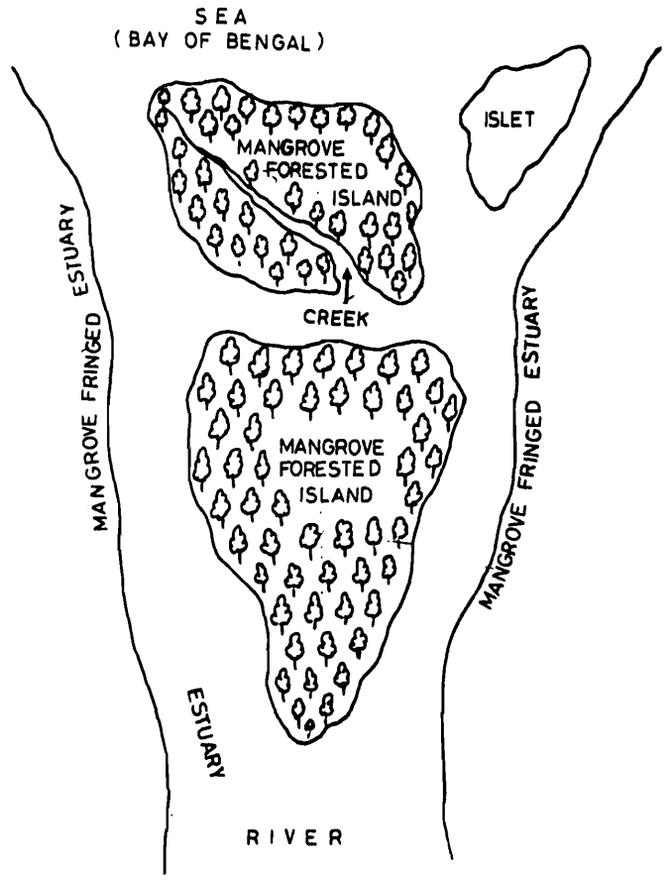
| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| ORDER : RODENTIA | | | |
| FAMILY : SCIURIDAE | | | |
| *Funambulus pennanti* Wroughton, Five-striped Squirrel | - | + | |
| FAMILY : MURIDAE | | | |
| *Mus booduga* (Gray), Little Indian Field Mouse | - | + | Fossorial |
| *Mus musculus* Linn., House Mouse | - | + | Around human habitation |
| *Rattus rattus* Linn.), House Rat | - | + | Fossorial |
| *Bandicota bengalensis* (Gray), Lesser Bandicoot Rat | + | + | Fossorial |
| *Bandicota indica* (Bechstein), Large Bandicoot Rat | + | + | Fossorial |
| FAMILY : ERETHIZONTIDAE | | | |
| *Hystrix indica* Keer, Indian Crested Porcupine | + | - | Fossorial |
| ORDER : CETACEA | | | |
| FAMILY : PLATINISTIDAE | | | |
| *Platanista gangetica* (Rouxburg), Gangetic Dolphin | - | + | Riverine |
| FAMILY : DELPHINIDAE | | | |
| *Neophocaena phocaenoides* (Cuvier), Little Porpoise or Black Finless Porpoise | + | + | Marine |
| *Orcella brevirostris* (Owen), Irrawady Dolphin | + | + | Marine |
| *Sotalia plumbea* (Cuvier), Plumbeous Dolphin | + | - | Marine |
| *Stanella malayana* (Lesson), Malay Dolphin | + | + | Marine |
| ORDER : CARNIVORA | | | |
| FAMILY : CANIDAE | | | |
| *Canis aureus* (Linn.), Jackal | + | + | Terrestrial |
| *Vulpes bengalensis* (Shaw), Indian Fox | + | + | Terrestrial |
| FAMILY : FELIDAE | | | |
| *Felis chaus* (Guldenstaedt), Jungle Cat | + | - | Terrestrial |
| *Felis viverrina* Bennett, Fishing Cat | + | - | Terrestrial |
| *Felis bengalensis* Kerr, Leopard Cat | + | + | Terrestrial |
| *Panthera tigris* (Linn.), Tiger | + | - | Terrestrial |
| FAMILY : VIVERRIDAE | | | |
| *Paradoxurus hermaphroditus* Gray, Toddy Cat | + | + | Terrestrial |
| *Viverricula indica* (Desmarest), Small Indian Cevet | + | + | Terrestrial |

| 1 | 2(i) | 2(ii) | 3 |
|---|---|---|---|
| *Herpestes edwardsi* (Geoffroy), Common Grey Mongoose | + | + | Terrestrial |
| *Herpestes auropunctatus* (Hodgson), Small Indian Mongoose | + | + | Terrestrial |
| *Herpestes palustris* Ghosh, Marsh Mongoose | - | + | Terrestrial |
| FAMILY : MUSTELIDAE | | | |
| *Lutra lutra* (Linn.), Common Otter | + | + | Aquatic |
| ORDER : ARTIODACTYLA | | | |
| FAMILY : SUIDAE | | | |
| *Sus scrofa* Linn., Wild Boar | + | - | Terrestrial |
| FAMILY : CERVIDAE | | | |
| *Cervus axis* (Erxleben), Spotted Deer | + | - | Terrestrial |

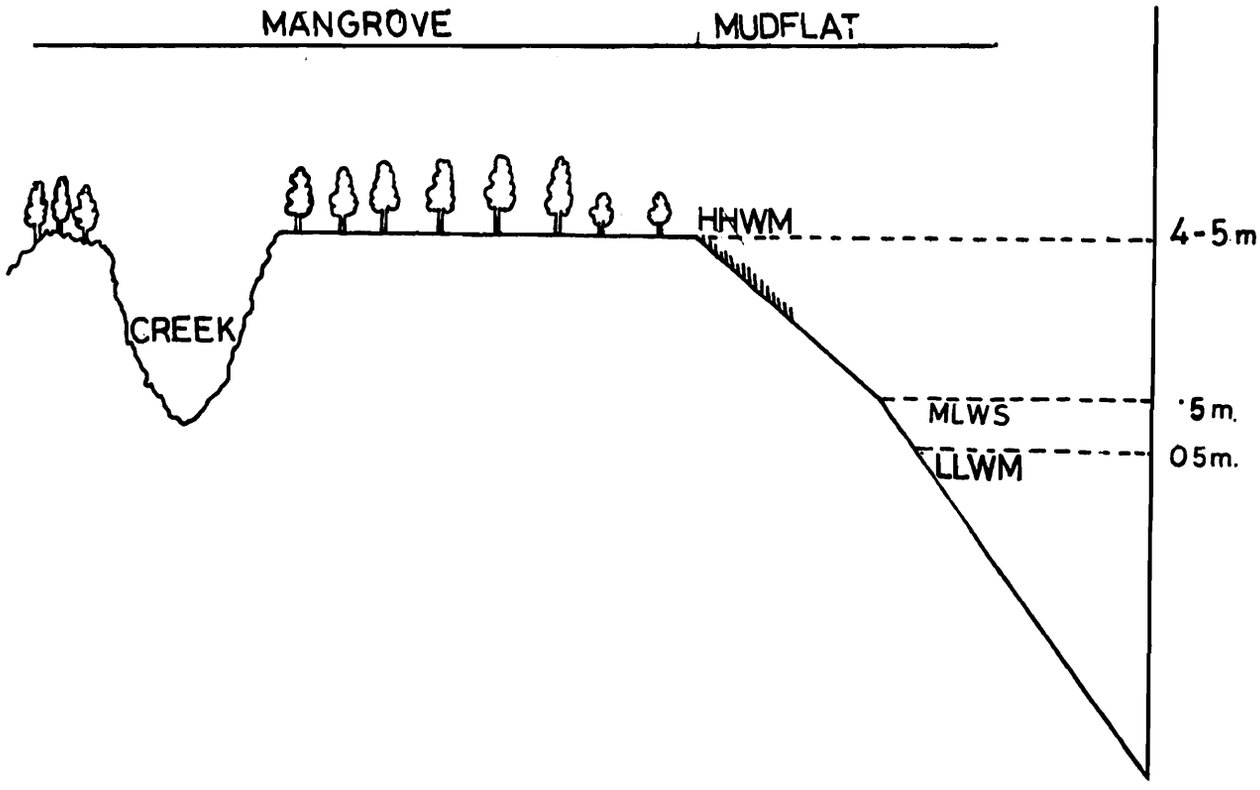
Terrestrial, brackishwater and marine fauna constitute the major faunal components in this ecosystem. Mangrove fauna occupy, in general, three different biomes, namely, littoral or supra-littoral forests, intertidal mudflat and estuary (Text figs. 3 & 4). The littoral or supralittoral forest biome is typically a terrestrial environment which includes both aerial and arboreal forms and the soil inhabitants. Arboreal animals and soil dwellers may be categorised as epifauna and infauna. The intertidal mudflats are essentially semiterrestrial or semiaquatic habitat supporting mainly the soil forms and the benthos. While the estuary is inhabited by aquatic forms, comprising of planktons and nektons.

The pattern of distribution of animals in mangrove ecosystem is influenced by the substratum, salinity, tidal amplitude, vegetation, light, temperature, etc.

The supra-littoral forest habitat includes areas where water may or may not reach at all and is essentially densely covered with halophytes. It offers forest floor, roots, stems, branches and leaves of trees as the abode. The intertidal mudflat proper is recognised as areas having periodical inundation and exposure i.e. either exposed or submerged with tidal flush for certain period of the day and is sparsely vegetated or with no vegetation at all in the lower littoral zone. The third biotope is the estuary or the creek which has characteristically low-saline brackishwater system.




**Text-fig. 3. Mangrove dominated island ecosystem - a model sketch.**




**Text-fig. 4. A schematic diagram showing the profile of Sundarban region.**

The aerial and arboreal forms mostly belong to different group of vertebrates. While the other faunal components in the mudflat and estuary can broadly be divided into zooplankton, nekton and benthos. Several species of crustaceans and larvae of fishes form the main component of the zooplankton in this region. The nekton is represented primarily by several species of fishes. The benthos can further be divided into micro, meio and macrobenthos, depending upon the size of mesh used. Mc Lusky (1971) suggested that the organisms which pass through a 40-60 μm sieve are microbenthos and the organisms retained by such sieve are meiobenthos. The organisms retained by a 500 μm sieve are known as macrobenthos. Mainly the bacteria and several species of protozoa come under microbenthos. The minute larval forms, and the free living nematodes can be placed under meiobenthos. The macrobenthos can be subdivided into epifauna and infauna. The epifauna are comprised of animals which can move or crawl over the surface or attach to some substrata provided by the mangrove. Several species of gastropod molluscs, hermit crabs, etc. are the common mobile epibenthos. The barnacles and a few species of bivalves are the sedentary epibenthos. The infauna are the animals which burrow inside the mud or wood of trees. The nemertean worms, polychaetes, bivalves and crabs constitute the main component of infauna found in the mud. The teredinid (shipworm) and isopod borers, which penetrate into the wood or trees, are the two different groups of infauna commonly known as woodborers. Most of the macrobenthos are detritus feeder, some of them live as filter feeder and some are deposit feeder.

While describing the mangrove fauna, various groups of animals have been categorised according to their habitat type, for convenience. But being mobile species the animals are always subjected to migration and/or local movements. Thus the fauna under one specific community may overlap with other habitat community, freely or frequently, as and when needed. However, the animals inhabiting mangrove environment have been placed under such group where they normally live, rest or spend most of their time, starting from tree downwards to ground and water.

## A. LITTORAL OR SUPRA LITTORAL FOREST FAUNA

Mangrove forest proper is inhabited by terrestrial animal communities. They may occupy tree or ground or both. Some have the power of flight.

Most of the mangrove animal communities show distinct zonation in relation to tidal height, but the tree fauna exhibit vertical zonation in the vegetation.

a. *The Tree Community*

Animals under this community include both aerial and arboreal forms. The upper canopy of mangrove trees is the home of birds, bats, monkeys and insects. Bat such as the Pigmy Pipistrelle, *Pipistrellus mimus* (Wroughton) can be found flying on the onset of evening inside the Project Tiger areas. It was collected from a roosting site at the campus of Sajnekhali Forest Office. A roost of *Megaderma spasma* Linn. was located in a temple at Gona Block of Sundarban Tiger Reserve. A few examples were also collected. The Shortnosed Fruit Bat, *Cynopterus sphinx* (Vahl) and the Large Indian Flying Fox, *Pteropus giganteus* (Brunnich) are quite common around human habitation especially in the scanty mangrove zone. The Rhesus Monkey, *Macaca mulatta* Zimmerman, the only species of Primate occurring in the Sundarban is well distributed in the entire forest. They are often found feeding on *'Keora'* trees (*Sonneratia apetala*) but are also well adapted to crab-eating. It is interesting to note that the herds of deer follow the troops of Rhesus Monkey from one Keora tree to another in search of leaves what the monkeys drop from the tree tops in course of their feeding.

Many species of birds build their nests in the mangrove trees. Herons, egrets, cormorants and darters enjoy roosting in colonies on the tall trees. Several species of birds use trunk, branches and aerial roots of mangrove as observation posts for feeding on fishes, molluscs, crustaceans, and aquatic insects. The king-fishers are mostly resident in the mangroves. The common species are the Blackcapped Kingfisher, *Halcyon pileata* (Boddaert), the Whitecollared Kingfisher, *Halcyon chloris* (Boddaert) (Plate 5, fig. 1) and the Brownwinged Kingfisher, *Pelargopsis amauroptera* (Pearson). There are a number of species of eagles and owls, the birds of prey, inhabiting mangroves. They are Whitebilled Sea Eagle, *Haliaeetus leucogaster* (Gmelin), Crested Serpent Eagle, *Spilornis cheela* (Latham), Pallas's Fishing Eagle, *Haliaeetus leucoryphus* (Pallas), Pariah Kite, *Milvus migrans* (Boddaert), Shikra, *Accipiter badius* (Gmelin), Barn Owl, *Tyto alba* (Scopoli), Scops Owl, *Otus scops* (Linnaeus), Spotted Owlet, *Athene brama* (Temminck) and the Brown Fish Owl, *Bubo zeylonensis* (Gmelin).

Passerine birds are not found much in mangroves. Bulbul, Myna, Shrike, Flycatcher and Finches are common, though not exclusive, to mangals. Common non-passerine birds which occur during the flowering and fruiting seasons (March to September) are parakeet, doves, barbets, rollers, cuckoos and crow-pheasants. Many of these birds feed on the fruits of Keora (*Sonneratia apetala*), Hental (*Phoenix paludosa*) and Genwa (*Excoecaria agallocha*).

In the Sajnakhali bird sanctuary, (Plate 5, fig. 2) a mixed heronry comes up every year duing breeding season covering an area of about 1 sq. km. Both resident and migratory birds build their nests from June to September. The Openbilled Stork, *Anastomus oscitans* Boddaert, an important resident species, comprise more than 50% of the total avifauna inhabiting the sanctuary. The rest of the population consists of Little Cormorant, Large Egret, Little Egret, Cattle Egret, Purple Heron, Night Heron, Blacknecked Stork and Pelicans. Chaudhuri and Chakrabarti (1973) estimated that this sanctuary produced 6864, 338 and 329 fledglings respectively of the Openbills, *Anastomus oscitans* Boddaert, Large Egrets, *Egretta alba* Linnaeus and Little Cormorant, *Phalacrocorox niger* Vieillot during 1971 breeding season.

Among insects, several species of butterflies, moths, dragon flies, damselflies, bees, wasps, fireflies, ants and beetles visit the mangroves. Mosquitoes and other biting insects are quite common. The abundance of mosquitoes make it impossible to enter into the forests. Most of the mosquitose belong to the genera *Aedes, Anopheles* and *Culex*. They are responsible for malaria and other mosquito-borne diseases in this area. *Anopheles sundaicus* is a predominant malarial mosquito of the mangrove environment in lower Bengal. These dipterans exhibit interesting breeding habits. They breed in the rot holes of the mangals as well as in accumulated water at the bases of leaves of *Nypa fruticans*. Mosquito larvae were encountered in water in rot holes of *Avicennia* spp. from different places of Sundarban.

The sound of cicadas during day time and the glittering of fireflies (*Pteroptyx* sp.) with the nightfall are characteristics in this wilderness of the Sundarban.

Flowers of some species of mangals attract honey bees, and offer opportunities for the production of honey. The Rock Bee, *Apis dorsata*, is an important species of commercial importance. They are known to build

their honey comb inside the forest in large numbers. Chakrabarti and Choudhuri (1972) have studied the behaviour pattern of the honey bee and estimated the production of honey from different species of mangals. About 39% of honey is produced from *Excoecaria agallocha* (Gnewa), 16% from *Avicennia* species (Baen), 11% from *Ceriops* species (Goran), 10% from *Rhizophora* species (Garjan) and only 24% from the rest of the plants. They have considered that *Phoenix, Excoecaria* (Hental-Gnewa) association are the ideal sites for comb formation.

The size of the comb varies from 35 cm to 125 cm in length. Honey from the nectar of *Aegiceras corniculatum* (Khalsi) and *Cynometra ramiflora* (Singra) is recognised as the best. About 600 groups of honey-collectors enter the forests with permits for honey collection. The collection of honey starts every year from March-April and continues for about two or three months in the Sundarban. The amount of production of honey per year is about 500 quintals and bees wax about 300 kg. Both tigers and monkeys exhibit their interest in honey and they do break the low lying combs for honey.

The tree trunks and the lower branches of mangals are inhabited by lizards, tree-frogs, ants and dominantly by snails of the genera *Littorina, Nerita* and *Cerithidea*. Snails like *Cassidula* and *Ellobium* and the slugs belonging to the genus *Onchidium* are also found in the mangrove. These arboreal species of molluscs feed on the algae and other organic debris of the trees.

During high tide these snails move up above the water level and stay on the branches or leaves as mobile epifauna. As soon as the tide recedes they move down to the moistened parts of the trees in search of food. It has been observed that the members of the genus *Littorina* can stay above the high tide level for prolonged periods and exhibit greater adaptation to terrestrial life. The other species may retreat to ground level during neap tide periods. On the tree trunks often live a species of ants viz. *Sima rufonigra*, the bite of which is painful and causes swelling, and both pain and swelling persists for a long time.

Large aggregations of branacles (*Balanus* spp. Plate 7, fig. 2) can be found on the lower mangrove tree-trunks, having periodical tidal flushing. These are filter feeding organisms and can only feed when covered by the

tides. This part of the tree trunk is also inhabited by bivalve milluscs (e.g. Oysters, Mussels) mainly at the seaward fringe of the mangrove forest. These animals live encrusted on tree trunks and comprise a group commonly known as sedentary epifauna.

A few species of snakes also inhabit the mangrove trees. These are common Indian Bronze Back, *Dendrelaphis tristis* (Daudin), Green Whip Snake, *Ahaetulla nasutus* (Lacepede) and Wolf Snake, *Lycodon aulicus* Linnaeus. Different species of Lizard and *Varanus* do live and/or visit mangals. The water Monitor, *Varanus salvator* (Laurenti) (Plate 8, fig. 5) is fairly common in the Sajnakhali Bird Sanctuary. They are known to predate on eggs and chicks during the breeding season in the sanctuary. In the mangrove environment the call of Gecko, *Gekko gecko* Linnaeus was heard from a Banyan tree introduced near Haldi Watch Tower within the Project Tiger area. The tree frog, *Rhacophorus maculatus* is found in the scanty mangrove zone. The mudskipper, *Boleophthalmus boddarti* is often found to climb up the tree trunks, prop roots or pneumatophores holding by means of the fused pelvic fins that act as a suctorial disk. The climbing is, perhaps, performed to avoid rising tides or for resting (De and Nandi 1984). The *Sesarma* crabs are also often seen to climb up the trees.

A large number of animals are known to inhabit the leaves, branches or trunks of mangrove. The gall causing insects and woodborers are two such groups of animals infesting the trees or dead wood. The galls may be found on leaves and twigs or the stems of living mangrove plants. Seven different kinds of galls were noted from mangroves specially infesting the *Avicennia* species. The gall insects, the larvae of lepidopterans and cerambycids, complete their life cycle causing much damage to the trees (Plate 6, fig. 1). A considerable damage to the dead wood of mangrove trees is also being done by the isopod and teredinid wood borers. A dead tree trunk or log exposed to tidal inundation, such as the piles of wooden jetty, is the specialised habitat of veligerid larvae of these boring bivalve molluscs (called shipworms). The larvae usually invade, enter inside, eat away the moist wood and become adults. Six species of teredinid wood borers have been reported from Sundarban. Other typically marine animals, such as isopods (*Sphqeroma* sp.) and amphipods are also likely to invade the tree and even the insect larvae. Crabs, too, may occur inside such wood holes, finding it a perfect hideaway. The infestation by termites is also not uncommon. The species like *Coptotermis heimi* and *Heterotermis indicola* are reported from this region.

b. *Ground Dwellers*

The forest floor of Sundarban is the domain of the Royal Bengal Tiger, *Panthera tigris* (Linnaeus). This forest is also the home of many ground dwelling wildlife species. Among mammals, ground fauna comprises of Fishing Cat, *Felis viverrina* Bennett, Spotted Deer, *Cervus axis* (Erxleben) (Plate 6, fig. 2), Wild Boar, *Sus scrofa* Linnaeus (Plate 8, fig. 3), Mongoose, *Herpestes* spp. Otter, *Lutra lutra* Linnaeus and Pangolin, *Manis pentadactyla* Linnaeus. The common mammal species of the forest are the Wild Boar and the Spotted Deer. The Wild Boars feed on underground tubers but also relish dead fishes, prawns, crabs, molluscs and sea turtle eggs. The Spotted Deer preferably browse on leaves, twigs and fruits of Keora (*Sonneratia apetala*) 'Baen' (*Avicennia officinalis*) and 'Gnewa' (*Excoecaria agallocha*). Herds of deer follow troops of Rhesus monkey from one Keora tree to another to pick up what the monkeys drop from tree tops while feeding. Two or three deer are seen in a herd inside the forest but in the open meadow the number increases to 40-50.

The Swamp Deer, *Cervus devaucelli* Cuvier, Hog deer, *Axis porcinus* Zimmermann and Barking Deer, *Muntiacus muntiak* Zimmermann were also present even at the fag end of the last century but now extinct from this part of the country. The Javan Rhino or Lesser One-horned Rhino, *Rhinoceros sondaicus* Desmarest and the Wild Buffalo, *Bubalus bubalis* (Linnaeus) have also become extinct from this region. The last authentic record of Javan Rhino from Sundarban is in 1893, which is based on a mounted specimen present in the Indian Museum, Calcutta.

Among the existing mammals the magnificent tiger has got the pride place as the top carnivorous animal occurring in the hazardous environment of the Sundarban. It leads an almost amphibious life and is quite capable of crossing wide rivers. It has well adapted itself in this difficult terrain which is characterised by sharp pneumatophores, muddy substratum, innumerable rivers and creeks with tidal rhythm, variable salinity and lack of freshwater source. It feeds on pigs, deer, even on fishes, crabs and water monitors. The Wild Pig constitutes the substantial proportion of its diet as the majority of tiger scats are predominated by the presence of pig hairs. This is in contrast to the common belief that the tiger mainly preys on Spotted Deer. It is generally believed that the tigers in this mangrove forest do not have

territories due to the obliteration of urination marks by the tidal waters. The alarming decline of global tiger population has attracted the attention of naturalists for the immediate conservation of this animal. World Wildlife Fund took up the issue, and the Project Tiger came into existence in 1973. Sundarban Tiger Reserve has a total area of 2,585 sq. km. and a core of 1,330 sq. km. which is the largest of all the Tiger Project areas in India. The population of tigers in this Reserve is about 264, as per last census in 1983, which is the highest concentration of tiger population in the country.

Tiger's preferred habitat, is the forests of *Phoenix paludosa* (Hental), pure or little mixed with *Sonneratia* (Keora) or *Avicennia* (Baen), According to Choudhury and Sanyal (1985) slight prey-predator gap exists in the buffer zone of Sundarban particularly along the human habitation which has caused the tiger to stray inside villages. Maximum straying occurs during February and May. Salinity of creek water appears to have some impact on the aberrative trend of these tigers. Man-eating propensity culminates in May even though the human entry into the biotope is minimum. The peak salinity in May coincides with peak human kill by tigers. Some tigers become so very fearless from the repeated lifting of man that they do not hesitate to board small boats at night for its human prey. However, it is not known whether all the tigers in Sundarban are man eaters.

There are Leopard Cats, Fishing Cats and other lesser cats inhabiting the forest. The Leopard Cat in the Sundarban needs rehabilitation at present. The population of fishing cat has declined drastically through out the world. The Project Tiger Authorities have taken up a study on the behaviour and breeding biology of this species. The population decline is also noticed among viverrid mammals occurring in the reclaimed areas. The Common Grey Mongoose (*Herpestes edwardsi*) is frequently met within the mangrove zone of Sundarban Tiger Reserve. In the scanty mangrove zone, *Herpestes auropunctatus* is common. The same is true for rodents representing Field Mouse (*Mus booduga*), Bandicoot Rat (*Bandicota indica*) Common Rat (*Rattus rattus*) etc. The Indian Creasted Porcupine (*Hystrix indica*) was once well represented inside the forest, but recently its number has declined to a great extent. Similar is the case with the Chinese Pangolin (*Manis pentadactyla*) which is also rarely seen.

Two species of birds belonging to the family Phasianidae, namely, Swamp Patridge (*Francolinus gulario*) and Jungle Fowl (*Gallus gallus*) are found dwelling on the ground in the densely forested part of Sundarban. The population of these two species has considerably reduced.

Among reptiles, *Varanus,* and snakes like Python, Cobra, Krait, and Vipers, are the ground dwellers. The population of these reptiles has become considerably reduced due to the commercial value of their skin. Many of these reptiles are at present protected under the Indian Wildlife (Protection) Act. The species of the genus *Varanus viz. V. salvator* (Water Monitor) and *V. flavescens* (Yellow Monitor) are carnivorous in habit and feed on crustaceans and molluscs. The water monitor is notorious consumer of bird-eggs and nestlings in the Sajnakhali Bird Sanctuary. For this reason the Project Tiger Authorities have placed thorny plants around the stem of trees nested by birds to minimise predation of eggs and chicks. Both viperid (Vipers) and elapid snakes (Kraits and Cobras) take shelter inside the burrows. They are very poisonous and quite a large number of death happen every year within the reclaimed area (Saha 1981, 1983, 1984, Saha and Hati, 1983). The need for proper scientific study on these precious species of Varanus and poisonous snakes is being felt for a long time.

Among amphibians, frogs and toads abound the scanty mangrove zone. Species of *Rana* are quite common on the ground as well as in water. During rains a large number of frog-catchers are seen in this area. Frogs (*Rana tigerina, R. crussa, R. hexadactyla*) are sold in the local market for export of frog-legs. The Common Indian Toad, *Bufo melanostictus* is terrestrial in habit.

The mangrove soil surface fauna and the soil infauna are comprised of snails, crabs, soil mites and the burrowing lobsters, *Thalassina anomala.* Gobiid fishes, snails and crabs (fiddler crabs and sesarmine crabs) are more characteristic to the mudflats, hence, discussed under intertidal mudflat fauna. The detritus feeding oribatid mites are reported from Sagar Island. The spider fauna of this region is represented by the genera *Lycosa* (Lycosidae), *Clubiona, Cheiracanthium* and *Castianeria* (Clubionidae), *Oxyopis* and *Puticia* (Oxyopidae) and *Nephila* (Pesauriidae). *Nephila maculata* Pocock is found resting on the selfmade big net of web having long tires, inside the forest. The Wolf Spider, *Lycosa* sp. has been collected from

a hole at the supralittoral zone. Its body is thickly covered with hairs which do not allow water to come in contact with the body proper. Invertebrate fauna of the mangrove forest floor have not so far been adequately attended to, though the ecological importance of soil fauna is quite significant.

## B. INTERTIDAL MUDFLAT FAUNA

Mudflat is herein considered as intertidal area and as such the species available in this zone may be referred to as intertidal fauna. Several species of birds, commonly referred to as marsh birds, a few species of aquatic snakes and the Estuarine Crocodile among reptiles, as well as the fishes like mud-skippers are encountered among vertebrates. The invertebrate fauna is represented mostly by both gastropod and bivalve molluscs, decapod crabs, larvae of insects, polychaetes, sea-anemones and other benthic forms. A species of hemichordates viz., *Saccoglossus* sp. is also found in this intertidal zone.

Among birds, different species of plovers (Family-Charadriidae) and sandpipers (Family-Scolopacidae) are frequently found hopping on the mud during low tide for food. They are popularly known as mud waders. When the habitats are flooded during high tides, these marsh birds are seen waiting patiently, perched on the branches of mangrove trees. The marsh birds which are found throughout the year are herons, egrets, bitterns, storks, rails, etc. The cattle egrets are often associated with other egrets, bitterns and herons in the scanty mangrove mudflats. Near the mud banks, flocks of sand pipers, redshanks and whimbrels are commonly seen in winter as migratory species.

In the mudflat and at the water edge, the common reptilian representative is the Dog-faced Water Snake, *Cerberus rhynchops*. The Estuarine Crocodile, *Crocodilus porosus* (Plate 8, fig. 2) also invades this area and found basking in the sun during winter months on the mudflat of big rivers.

Almost all the mudskippers available in this region are found hopping on the mudflats and burrow inside the soft soil specially at the time of breeding. They are dealt with in detail while describing the estuarine fauna. A species of eel fish, *Pisoodonophis boro* (Plate 9, fig. 1) has also been encountered in the lower littoral mudflat.

The soil surface is occupied by the snails belonging to the genera, *Littorina, Nerita, Natica, Cerithidea, Neritina* (Plate 10, figs. 1-6) *Telescopium* (Plate 4, fig. 2) *Pythia, Stenothyra, Haminea, Assiminia, Onchiduim,* etc. as the dominant mobile epibenthos. The presence of two species, one each of *Neritina* and *Littorina,* in the mangrove areas and their subsequent absence in nonmangrove areas is interesting (Mandal and Misra, 1986). Of all the crawling gastropod molluscs the gregarious habit of *C. obtusa* and *T. telescopium* is very much prominent particularly within the halophyte zone, where there is a little flow of water along with the growth of the grass, *P. coarctata.*

The population density of a number of gastropod snail species was recorded by Subba Rao *et al.* (1983) from the scanty mangrove habitat of Muriganga estuary. According to them neritids occur either solitary or in clusters of 7-9 individuals. *Assiminea brevicula* was the dominant species, accounting for 81.3%-97.5% of the total molluscan population. The two sympatric species of *Assiminea* viz., *A. brevicula* and *A. beddomeana* share two different ecological niches, the former being the surface form while the latter lives in holes and crevices of the mudflats.

The crawling anomurans or the hermit crabs belonging to the genera *Clibanarius* (Plate 11, figs. 1 & 3) and *Coenobita* (Plate 11, fig. 2) are common, particularly towards the sea facing areas. They use the shells of several species of molluscs, namely, *Telescopium, Cerithidea, Nerita* and *Littorina* and live inside. Sometimes the floating shells of marine molluscs are being used by them for shelter.

Amongst infauna, crab constitutes the most abundant group. The genera like *Metaplax, Metapograpsus, Sesarma, Dotillopsis* and *Uca* are predominant (Plate 12, figs. 1-5). *Dotilla* spp. prefer to live near low water mark in the sand, whereas, *Dotillopsis* are found in the mud of softest consistency. *Uca* spp. constitute one of the dominant crab fauna of the intertidal mangrove areas. Four species viz. *Uca acutus* (*U. roseus*) *U. annulipes, U. dussumieri* and *U. triangularis* are quite common. The members of the family Grapsidae, namely, the genera *Sesarma* and *Metaplax* are found in the estuaries and as well as in the areas with very low or devoid of salinity. The members of the genus *Sesarma* prepare a deep hole on the marshy ground. An important edible crab, *viz., Scylla serrata* is also found to occur abundantly in the intertidal mudflat as burrower.

The next abundant group is the polychaete both in number of individuals and number of species. The genera, namely, *Diapatra, Glycera, Namalycastis, Lumbrineris, Prionospio,* etc., are quite common. It has been seen that almost in each sampling from mudflats, some polychaetes are always present. Misra and Choudhury (1986) encountered 30 species belonging to 24 genera spread over 13 families from this region. The nereids, eunicids and capitellids are considered to be abundant. The tubiferus polychaetes like *Diapatra* sp. (Plate 13, fig. 2) of the family Onuphidae and *Spio* sp. of the family Spionidae are found to be abundant in the mangrove fringed areas. From the mangrove areas *Marphysa* sp. of the family *Eunicidae, Lumbrineris* sp. of the family Lumbrineridae and *Laonome sp.* of the family Sabellidae have been collected in fair numbers. As the physical or chemical parameters have not been taken into account while collecting these organisms during our general faunistic survey, it is difficult to come to any positive conclusion as to the causes which govern their presence or absence in the mangrove zone or in the areas devoid of mangrove.

The bivalves, namely, the genera *Meretrix, Dosinia, Macoma, Modiolus,* (Plate 10, fig. 7) *Arca, Strigilla, Solen, Theora, Pharella* and *Tellina* are the important infauna of the mudflat habitat. The members of the genera *Tellina* and *Dosinia* go very deep even upto 10 cm or so. The commercially important bivalves, *Dosinia trigona, Anadara granosa, Meretrix meretix* and *Crassostrea gryphoides* (Plate 10, figs. 8-12) are found in the submerged zone of the estuaries assedmentary epibenthos. The shells of these species are widely used for making shell powder and shell grit for poultry feed purposes at different shell crushing centres of coastal West Bengal (De *et al,* 1987). An estimated 1200 tonnes of shells are crushed annually (Bojan, 1984).

The echiurids and sipunculids are represented in this region by a few species only. The common echiurid is *Anelassorhynchus branchiorhynchus* (Annandale and Kemp) and the other species is *A. dendrorhynchus* (Plate 14, fig. 1). They dwell in holes with more than one opening at the lower littoral zone only temporarily exposed for 2-3 days in each lunar cycle. The sipunculids, namely, *Phascolosoma arcuatum* is quite abundant specially in the upper mudflat zone of transitorily terrestrial substratum (Mandal and Misra, 1986). They suck up surface mud by extending their long proboscis while remaining in the safe position inside the burrow.

*A. branchiorhynchus* usually occurs in hard and sticky substrata or black humous soil often in association with a polychaete and isopod.

The lone representative of the hemichordate, namely, *Saccoglosus* sp. has been recorded from Jhingakhali, Raidighi and Gosaba by the present authors. It was first recorded from Prentice island by Singh and Choudhury (1984). The nemertean worm is found in the loamy soil within the halophyte zone, and several examples of this flat worm have been collected from different regions of Sundarban.

The sea anemones are represented by the genera *Pelocoetes, Edwardsia* and *Phytocoeteopsis.* They are found adhering to the mud or any other substrata, even the floating or fallen logs periodically inundated, and form colonies. They occupy a definite zone in the mudflats which are characterised by the flushing of tidal water and only exposed for a short period at different lunar phases. In some places like Namkhana (Plate 2, fig. 2) Pathar Pratima, Port Canning and Jharakhali, sea anemones are found to dominate the lower littoral mudflat. Choudhury *et al.* (1984) observed that in the mudflat of Prentice Island, actiniarians stand as the most abundant group, with 65.1% of the total population.

On or by the side of the embankments enormous mounds of the thalassinid shrimp or locally called 'Patal Chingri', *Thalassina anomala* (Plate 12, fig. 6) have been encountered. This shrimp goes very deep inside upto a depth of 1.5 metres, and the hole has always more than one branches inside, having connections with nearby estuaries, where the larvae of this shrimp can grow till they become adult and lead a subterranean life. A species of stomatopod has also been found to live in burrows at the mid littoral zone at least for some part of their life.

Though not much work has been done on the larvae of insects occurring in the mudflats but recently a Rove Beetle, *Bledius* sp. has been reported from sandflats of Sagar Island by Podder and Choudhury (1986). They have noticed the vertical movement of this beetle which varies seasonally. The larvae of this species were found to move towards the upper layer from June to December. Two more tabanid larvae *Atytolus agrestis* and *Tabanus striatus* have also been collected by Ray and Choudhury (1986) from the same locality. Of these *A. agrestis* has been reported to be abundant. They further claimed that this species 'appears to be a genuine resident of

mangrove ecosystem' The larval and pupal stages of *Culicoides oxystoma* have also been recorded by Ray and Choudhury (1986) from the same region. They have noted their absence within the desired depth of the soil when the moisture content was less than 19.8% and the temperature above 34.9°C.

The study on the meiofauna from this region was initiated by Linstow (1907) by describing a new species of nematode belonging to the genus *Oncholaimus* from Port Canning. After a long gap, Rao and Misra (1983) reported that the nematodes and harpacticoid copepods constitute the main component (80%) of the meiofauna of Sagar Island. In addition, turbellarians, polychaetes, oligochaetes, ostracods, isopods, amphipods, cumaceans, halacarids have also been obtained in small numbers. The hydrozoans and nemerteans were found to be rare. Recently, Sinha and Baqri (1984) described another species of nematode of the genus *Mylonchulus* from the same locality. Sinha and Choudhury (1986) reported the occurrence of rhabditid nematodes from the same region.

The role of meiofauna along with the soil bacteria and fungi has vividly been described by Macintosh (1986), specially their role in the food web of mangrove ecosystem, both for production of detritus as well as offering themselves as a source of food for the macrofauna.

The major bulk of microbenthic forms, are represented by protozoans belonging to the groups Sarcodina and Ciliata. Rao and Misra (1983) observed some species of foraminiferans while studying the microfauna of Sagar Island, Sundarban.

Recently, Ghosh, Singh and Choudhury (1986) isolated a Gymnamoeba, *Acanthamoeba rhysodes* from the soil of Sagar Island. They have considered *Acanthamoeba* as micropredator in the mangrove swamp of Sundarban, and mainly feed on bacteria (Choudhury and Ghosh, 1985). Bhaumik *et al.* (1986) have isolated 24 strain of bacteria from the decomposed litters of Sundarban mangrove Swamps.

## C. ESTUARINE FAUNA

Mangrove ecosystem is always associated with estuaries and as such many estuarine animals are part and parcel of mangrove fauna. These animals either inhabit or visit the mangrove biotope for various needs of life.

About half of the total area of Sundarban is covered by water sheets and the estuarine complex constitute the major part of it. This ecotonal zone is considered as highly productive, having connections with the sea at one end and the freshwater rivers on the other. Due to its unique topographic position, a large number of aquatic fauna are being attracted which includes from the tiny amoeba to the mighty crocodile, besides several colourful water birds and some species of aquatic mammals belonging to the order Cetacea.

The aquatic mammals in the estuarine river and creeks are represented by the dolphins and porpoises. The Plumbous Dolphin, *Sousa plumbea* Cuvier, Malay Dolphin, *Stanella malayana* and Irrawaddy Dolphin, *Orcella brevirostris* Owen are seen in the rivers of this region. The famous Black Finless Porpoise, *Neomoris phocaenoides* (Cuvier) is also quite common along with the Gangetic Dolphin, *Platanista gangetica* (Roxburgh). None of these ceteceans is exclusively confined to the estuaries. They enter estuaries either from freshwater rivers or from sea. However, all, except the Gangetic Dolphin, *Platanista gangetica,* are marine. These animals are partly dependent for their food on estuarine fauna and flora. Being voracious eaters they play an important role in the food chain of estuarine ecosystem. In India, very little attention has been paid to the study of these important aquatic mammals. The Common Otter, *Lutra lutra* (Linn.) is also found in these rivers. They prey on fishes in the creeks, tidal streams and estuaries and are well adapted for swimming.

Sundarban in its aquatic habitat harbour a wide variety of water birds. Among anatids, the Cotton Teal, *Nettapus coromandelianus* (Gmelin) is an important resident species. A large proportion of water birds are migratory in habit. This includes, Common Teal (*Anas creca*), Pintail (*Anas acuta*), Mallard (*Anas platyrhynchos*), Common Pochard (*Aythya ferina*), etc. The Cormorants (*Phalacrocorax niger*), Darters (*Anhinga rufa*) and Dabchick (*Podiceps ruficollis*) are found throughout the year. Several species of gulls and terns are very common in the coastal water and around large rivers specially at the fishing sites like Frasergunge, Jambudwip, Bakkhali, etc. Some terns (*Sterna albifrons* (Plate 8, fig. 4), *S. aurantia, S. bengalensis* and *S. bergii*) and the Skimmers (*Rynchops albicollis*) are found all the year round. The seasonal visitors are the following species of gulls viz. *Larus brunnicephalus, L. ridibundus, L. argentatus* and terns viz, *Sterna fusca,*

*S. hirundo, Chlidonias hybrida* and *Hydroprogne caspia,* etc. Bioecology of these species of water birds, besides food and feeding habits studied by Mukherjee (1969, 1971, 1972, 1974), have not yet been worked out.

The reptilian fauna of these estuaries are represented by a number of sea snakes, turtles and crocodiles. The sea snakes, namely, *Hydrophis obscurus* (Daudin), *H. nigrocinctus* Daudin, *H. caerulescens* (Shaw), *Microcephalophis gracilis* (Shaw) and *M. cantoris* Gunther are quite common. They are considered as highly poisonous. Their existence is best observed from the bag net catches at the time of fishing. The Dogfaced Water Snake (*Cerberus rhynchops*) is very common along the estuarine rivers of Sundarban.

Turtles and terrapins are represented by *Batagur baska* (Gray); Olive Ridley Turtle, *Lepidochelys olivacea* (Eschscholtz) (Plate 8, fig. 1), Ganges Softshelled Turtle, *Trionyx gangeticus* Cuvier, Peacock Marked Softshelled Turtle, *Trionyx hurum* Gray and Indian Flapshelled Turtle, *Lissemys punctata* Bonnaterre. Being an endangered species, captive rearing and rehabilitation of the Olive Ridleys (*Lepidochelys olivcea*) have been initiated at Bhagabatpur Crocodile Rearing Centre and Sajnakhali Hatchery, by the Forest Department, Govt. of West Bengal. Banerjee (1984, 1985) obtained 117 hatchlings out of 600 eggs collected from 4 nests at Kalash Island, Sundarban i.e. 19.5% hatching success at Bhagabatpur Hatchery. However, 51% hatching success has been achieved by Sanyal (1984) and 22% by Saha (1984) from Sajnakhali Hatchery. In captivity it has been observed that the infant Olive Ridleys feed greedily on chopped fish and minced prawn feed, and at the age of 10 months, the young ones are capable of capturing live fish fry and prawns (Banerjee *et al.* 1986a). The rate of growth of juvenile ridleys and the skin infection have also been reported by Banerjee *et al.* (1986b, 1987). Recently, Raut and Nandi (1985) have reported on the present state of Ridley Turtle conservation and management in West Bengal. Net-bound death of 438 marine turtles, off West Bengal coast during 1984-85 has also been reported by them (Raut and Nandi, 1986). Banerjee *et al.* (1985) reported 44.4% infantile mortality of Olive Ridleys in captivity.

Although the saltwater or Estuarine Crocodile, *Crocodylus porosus* (Schneider) is found in the river, it invades the exposed muddy areas at will. It can also be found on land amidst thick mangrove forest. The juveniles eat

on small fishes and crustaceans, while adults devour larger aquatic animals and even attack on human. Biswas (1983) and recently Banerjee *et al.* (In press) reported on the food and feeding habits of the Estuarine Crocodile, *Crocodylus porosus* in captivity. The captive breeding of a wild caught female from Bhagabatpur Crocodile Farm, Sundarban, was reported by Acharya (1985).

Like the tiger population in Sundarban, the population of crocodile has declined to a great extent due to the indiscriminate killing mainly for the constant demand of their skin for luxury goods. With the establishment of a crocodile farm at Bhagabatpur, Lothian Island in March 1976, the rearing was initiated along with the collection of eggs, their hatching and rehabilitation. As a result, a sizeable population of this species has been restored at present in the estuaries of this region.

Banerjee *et al.* (1984) have reported the nesting sites of this species in the islands by the side of Kastura Khal and Manasa Khal of Thakuran Forest Block, Ajmalmari River of Ajmalmari Forest Block, Herobhanga Khal of Herobhanga Forest Block and Amlamethi Khal of Pirkhali Forest Block, Sundarban. Banerjee (1985) has also reported on the nest guarding behaviour among crocodiles in the Sundarban.

Most of the fishes found in this estuarine complex are from the sea. They are available either in the form of larvae or as adult. The gobiids and clupeids are known to breed and complete their life cycle in the estuary. *Hilsa, Pama, Polynemus,* etc. are exclusively marine but travel through estuaries to the upstream for breeding (anadromous) and again go back to the sea. Some of the freshwater fishes are catadromous and they enter the estuary for breeding. Eel. (*Anguilla* spp.) and *Pangasius* are common amongst them. Several species of sharks and rays also invade the estuary. The genera like *Scoliodon, Pristis, Sphyrna, Rhinobatus, Dasyatis* and *Aetobatis* are common. Some places are so heavily infested with sharks that it becomes difficult to bathe in these rivers.

The potentiality of fisheries inside the mangrove zone is quite evident from a large number of Catfishes, Mugil, Bhetki occurring in the estuaries. This zone acts as a nursery ground for many fishes. A table (Table 4) representing the catch from different rivers within the mangrove zone is appended to have an idea about the fishes and the quantity of there catch from different regions.

Table 4. Indicates amount of fish procured (in Kilograms) in December 1971 from the estuarine river system of Namkhana Range. After Chaudhuri and Chakrabarti, 1974: *Sci. & Cult.*, 40(3): 93-99.

| Locality within 24 - Paraganas | Common Name of Fishes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parse | Bhetki | Hilsa | Pompret | Bhola | Topse | Chanda | Datne | Sale | Bhangan | Fesha | Medh | Sankar | Chingri | Total |
| Thakuran | 3,193 | 537 | 20 | 20 | 1,295 | 25 | 72 | 9 | 61 | 75 | 134 | 35 | — | 8,272 | 13,741 |
| Saptamukhi | 130 | 17 | — | — | 77 | 8 | — | — | — | — | — | — | 25 | 225 | 482 |
| Vidya | 30 | 30 | — | — | 10 | — | 15 | — | — | 17 | 5 | — | — | 75 | 162 |
| Chotovidya | 20 | 8 | 80 | — | 10 | — | — | — | — | 40 | 30 | — | — | 80 | 268 |
| Kalash | 80 | 50 | 50 | — | — | — | — | — | 10 | 15 | — | — | — | 60 | 265 |
| Bainchapi | 15 | 40 | 40 | 75 | — | — | 10 | — | — | 5 | — | — | — | 180 | 305 |
| Dhuli Bhasani | 75 | 15 | 15 | 20 | 80 | — | — | — | 15 | 25 | 25 | — | — | 60 | 330 |
| Banifuli | 508 | — | — | 10 | 80 | — | — | — | — | 10 | — | — | — | 358 | 966 |
| Matla | 25 | — | — | 3 | — | — | — | — | — | 30 | 20 | — | — | 20 | 98 |
| Herobhanga | 10 | 25 | 25 | 15 | 30 | — | — | — | 10 | 20 | 40 | — | — | — | 175 |
| Maipit | 30 | — | — | 25 | 15 | — | 20 | — | — | — | — | — | — | 25 | 105 |
| Dhinchi | 30 | 20 | 20 | 15 | 15 | — | 30 | — | — | 5 | 10 | — | — | 10 | 155 |
| | 4,146 | 722 | 250 | 116 | 1,612 | 33 | 147 | 9 | 96 | 242 | 264 | 35 | 25 | 9,365 | 17,052 |

The fishes and fisheries of mangrove ecosystem is a very vast subject. Though a list of fishes available in this region has been appended, yet the common fishes connected with the fishery is mentioned here, along with the famous gobiid fishes of this region which are very common and frequently seen even by a casual visitor.

Most common gobiids are *Boleophthalmus boddarti* Pallas, *B. histophorus* Valenciennes, *Periopthalmus schlosseri* (Valenciennes), *P. pearsei* Eggert, *Gobiopterus chuno* (Ham), *Brachygobius nanus* (Ham) and *Gobius elegans* (Kulp and V. Hass). They are popularly known as mudskippers. They move along with the oscillation of water in the river bed. Sometimes they are found hopping on the mud with the help of a pair of pectoral fins, modified accordingly, and act like crutches during locomotion on land (De and Nandi, 1984).

The eel, like *Anguilla bicolor* McClelland, *Pisoodonophis boro* (Ham) and Pike eel, *Muraenesox cinereus* (Forskal) are also quite common. *Pangasius pangasius* is a species of fresh water fish but it breeds in the estuary. It feeds on *Sonneratia* fruits fallen in the river. Several species of *Arius, Mystus, Osteogeniosus* and *Polydactylus* have also been encountered. Another important cat fish, *Plotosus canius* is found in abundance and is suitable for the human consumption. *Liza tade, L. parsia, Lates calcarifer* are the most preferred common fishes of Sundarban. The Bombay duck, *Harpodon nehereus,* and the Ribbon fish, *Eleutheronema tetradactrylum* are vividly consumed by the local people. The species of the genus *Hilsa* are considered as the delicious fish. However, *Scatophagus argus, Gadusia chapra, Polynemus paradiseus,* etc., comprise good fishery from this region.

The fisheries of this area can not be completed if the huge amount of shrimps and prawns are not taken into account along with edible crabs. Prawns are represented by the highly priced Bagda, *Penaeus monodon* Fabricius (Plate 15, fig. 1) and the Galda, *Macrobrachium rosenbergi* (De Man). Shrimps like Kucho Chingri, *Macrobrachium lamarei* (Milne Edward), Goda Chingri, *M. rude* (Heller), Chapra Chingri, *Penaeus indicus,* Honne Chingri, *Metapenaeus monoceros,* Chamne Chingri, *M. brevicornis,* Nona Chingri, *Parapenaeopsis sculptilis* and Ghuso Chingri, *Acetes* sp. are the common forms found in these estuaries.

Most common edible crab is the *Scylla serrata* (Forskal) (Plate 15, fig. 2). The Chiti Kangra, *Varuna litterata* (Fabricius) is also being consumed and has a moderate market value.

Nandi and Ghatak (1985) estimated that the potential resource of crabs of commercial importance from coastal West Bengal (which includes greater proportion of the mangrove habitat) would be to the tune of 3300 tonnes. Nandi and Pramanik (1986) have reported on the crab fishery and landing of *Scylla serrata* (Forskal) from Budhakhali landing centre, Sundarban, West Bengal. According to them an estimated 4.13% people of the total population of Budhakhali Gram Panchayet are engaged in crab fishing. The estimated landing of *S. serrata* at this landing centre was 142.7 and 149.7 tonnes during the year 1984 and 1985 respectively.

Aquatic insect fauna of this region has not been properly attended to so far. The occurrence of some Hemiptera from the brackishwater pond at Port Canning by Distant (1902, 1910) is considered as the begining. The species *viz. Mesovelia mulsanti* White, *Microvelia annandeli* Dist., *Gerris fossarum* Fabr., *G. tristan* Kirk, *Anisops breddini* Kirk, *Micronecta lucina* Dist., and *M. merope* Dist. have been encountered. A few species of chironomid larvae belonging to the genera *Polypedium* and *Aulinogyra* have been encountered by Sarangi (1983). As much as 12 species of dipteran larvae have been collected from Sagar Island by Ray (vide Maiti and Nandi, 1985) belonging to the families Ceratopogonidae, Chironomidae, Culicidae, Ephydridae and Tabanidae. Nearly 15 species of Coleoptera have also been collected from the same area belonging to the family Carabidae, Dystiscidae, Halliplidae, Cicindelidae Staphylinidae and Heteroceridae.

The macropelagic forms are represented by Jelly fish *Acromitus rabanchatu* Annandale. It is particularly seen towards the river mouth. Nandi (1984) reported that the swarms of jelly fish occur on the surface of water of the Hooghly-Saptamukhi estuary from middle of December to the middle of March when the salnity ranges from 6-14%. Sometimes the occurrence of swarms of jelly fish in huge numbers poses a threat to captive fishery in the Sundarban. The squids, cuttle fish and octopus are also frequently encountered at the time of hauling fishes from the estuary.

Two species of Squilla, namely, *Squilla raphidea* and *S. scorpio* are quite common in the estuaries (Plate 10, fig. 4 & 5). The king crabs are reported

from the coastal region and the common species is *Carcinoscorpius rotundicauda* (Latreille) (Plate 7, fig. 1). The other less common species is *Tachypleus gigas.*

Within the zooplankton copepod constitutes the dominant group. While studying the species composition of zooplankton, Sarkar, Singh and Choudhury (1986) obtained three distinct categories of population in the estuaries at Sagar Island as given below.

The species present throughout the year are *Paracalanus* spp., *Acrocalanus* spp., *Acartia* sp., *A. spinicauda, Labidocera euchaeta, Pontella andersoni, Eucalanus subcrassus, E. elongatus, Pseudodiaptomus annandalei, P. hickmani, Microsetella rosea* and *Laophonte* spp. Species present for a limited period are *Pseudodiaptomus aurivilli, Euchaeta marina, E. wolfendeni, Euchaeta* sp. *Centropages dorsispinatus, Acartiella sewelli, Corycaeus danae, Euterpina acutiforns, Cladorostrata brevipoda, Harpacticus* sp., *Clytermestra scutellata* and *Macrostella gracilis.* The following species have been shown as casual migrant, *viz., Acartiella keralensis, Labidocera* sp., *L. minuta, Pontellopsis herdmani, Eucalanus* spp., *Pseudodiaptomus* spp. *P. tollingeri, P. masoni, P. binghami, P. daughlishi, Neodiaptomus strigilipes, Euchaeta tenuis, E. corcinna, Centropages furcatus, Temora turbinata, T. discaudata, Tortanus gracilis, T. forcipatus, Candacia bradyi, Canthocalanus pauper, Undinula darwini, Corycaeus catus, C. agilis, Oncaea venusta, Halicyclops tenuispina, Mesocyclops* sp. *Cyclops* sp. *Tachidius discipes.* They have also reported a single species of Mysidacea e.g. *Mesopodopsis orientalis.* Other crustacean holoplankters reported by Sarkar *et al.* (1985) are Sergestidae as *Lucifer hanseni;* Cladocera as *Evadne* sp.; Ostracoda viz., *Philomedes* sp., and a single species of Cumacea viz., *Paradiatylis* sp., along with several gammarid species of Amphipoda.

Among non-crustaceans holoptankters, the phylum Chaetognatha is represented by two species, viz., *Sagitta bedoti* and *S. enflata,* while hydromedusae was sporadically represented in the premonsoon period. Among meroplankters, polychaete larvae appeared in considerable numbers during postmonsoon period. The crustacean larval stages were represented by nauplius, zoea and megalopa almost throughout the year. But decapod larvae (*Penaeus monodon P. indicus, Metapenaeus monoceros, M. dobsoni* and *M. affinis.*), fish egg and larvae and the larvae of anomuran and *Alima*

were presented during certain months. A few samples have been collected from the Matla river during the Tiger census in 1983. It has been observed that the crustaceans and fish larvae constitute the main component. The copepods, decapods, amphipods, ostracods, mysids and cladocerans among Crustacea, the larvae of several species of Prawns and Shrimps and larvae of Mugil, Mudskipper and Chanos fish have also been seen in the sample. Chaetognaths and the cypris of Balanus were also noted. It is also mentioned that fortnightly sampling in a Kakdwip canal of Hooghly estuary with the help of shooting net has revealed a representation of more than 75% of the total catch by crustacean larvae (nauplius and megalopa stage) during the monsoon months (July-Sept)in 1983. Copepods constitute the principal component of the zooplankton population even though the protozoans outnumber them. Protozoans and rotifers are found in abundance in less saline areas.

Among flagellates, common genera are *Euglena, Ceratium, Phacus, Peridinium* and *Noctiluca.* In the Matlah estuarine zone, the peak period of occurrence of *Euglena* spp. was July-September months. Of the protozoans, common genera are *Difflugia, Arcella, Vorticella, Centropyxis* and *Tintidinium. Difflugia* occurs in abundance during July-September period in the Matla estuary while *Vorticella* population reaches its peak during September-November months in the Hooghly estuary.

Though rotifers are not rare in the salt water microfauna of Hooghly-Matlah estuarine system, but they are not so conspicuous in such habitats as in freshwater system. Most rotifers are smaller than 0.5 mm and vary widely in habits and habitat preferences. Common genera of rotifers in the Sundarban estuarine system are species of *Branchionus, Keratella, Asplanchna* and *Notholca.*

## D. PARASITE FAUNA

Not a single case of infection of ectoparasites like mites, ticks, fleas and lice has so far been reported from the animals of this region inspite of the considerable existence of wildlife. Of course the difficulties in examining these parasites in wild animals are known to all. However, the isopod parasites have been recorded from a number of fishes and the common one is *Nerocella madrasensis* infecting the catfishes. A species of cymothoid isopod parasite, *Cymothóa indica,* has also been reported from the gar pikes

fish, *Strongylura strongylura,* from Hooghly estuary by Misra and Nandi (1986). The occurrence of a bopyrid isopod parasite, *Probopyrus gangeticus* in the prawn, *Palaemon styliferus* is quite common (Raut and Nandi, 1985).

The parasitofaunal component of this region is mainly due to Mandal and Choudhury (1986). Protozoan parasites viz., *Monocercomonas ruminantium* and *Eimeria cervis* from spotted deer, *Dientamoeba fragilis* from *Macaca mulatta,* and *Copromonas ruminatum, Tetratrichomonas butteryi* and *Balantidium coli* from *Sus scrofa* have been reported from this region by Mandal (1982) and Mandal and Choudhury (1982, 1984, 1985). Two piroplasmids viz., *Babesia muris* from rat and *B. vesperuginis* from *Scotophilus kuhli* have also been reported by Mandal (1982).

The haematozoa of estuarine fishes of lower Bengal has been extensively studied by Mandal (1984) and a *Haematactidium* sp. and a *Babesiosoma* sp. have been reported from two species of fishes. The paucity or absence of various blood parasites in estuarine fishes is normally due to the scarcity or absence of leech-vector in this estuarine complex. The infection in the above two genera might have come from marine habitat. A few species of coccidian parasite have been reported from some mud-waders examined by Mandal (1965). Two new species of myxosporidian parasites viz., *Ceratomyxa sagarica* and *Myxidium boddartii* from the Mud Skipper, *Boleophthalumus boddarti,* were described by Choudhury and Nandi (1973). The microfilaria stage and adults of *Breinlia booliati* have been reported from *Rattus rattus arboreus.* The helminth parasites, namely, *Toxocara cati, Gnathostomum spinigerum, Ollulanus tricuspis* and *Troglotrema* sp. have been reported from Tiger. From our study on tiger scats only one instance of *Toxocara* sp. has been encountered in a Tiger visiting the Sajnakhali freshwater tank.

A perusal of literature revealed that there are a few reports of Monogenea from fishes of Hooghly-Matlah estuary. They are *Dactylogyrus gobii* Tripathi from *Glosogobius guiris, Actinocleidus leiognathi* Tripathi from *Leognathus edentalus, Ancyrocephalus johni* Tripathi from *Lutianus johni, A. nengi* Tripathi from *Osteogenlosus militaris, A. indicum* (Tripathi) from *Platycephalus insidiator, Haplocleidus pangasi* (Tripathi) from *Pangasius pangasius, Neomurraytrema tengra* Tripathi from *Mystus gulio, Tribaculocauda discoidea* Tripathi from *Hemirhamphus georgei, Diplectanum latesi* Tripathi from *Lates calcarifer, D. puriense* Tripathi from *Sillaginopsis*

*panijus, D. secundum* (Tripathi) from *Therapon jarbua, Lamellodiscus indicus* (Tripathi) from *Sparus sarba, Paramazocraes phasae* Tripathi from *Setipinna phasa, Octoplectanocotyla trichiuri* Yamagutt from *Trichiurus savala* and *T. muticus, Microcotyle pamae* from *Pama pama, M. polynemi* MacCallum from *Eleutheronema tetradactylus, Indocotyle hemirhamphae* Tripathi and *Axine tripathi* Price from *Hemirampus georgii.* Like Mongenea, digenetic trematodes have also been described from Hooghly estuary *viz., Aphanurus breviformes* Srivastava and *Aphanurus stossichi* (Monticelli) from *Ilisha elongata; A. stossichi* from *Coilia ramcarati; Paradactylostomum indicum* Zhukov, and *Aphanurus stossichi* (Monticelli) from *Engraulus telara; Lecithochirium acutum* Chauhan from *Harpodon nehereus; Stomachicola muraenesocis* Yamaguti, from *Muraenesox talabonoides, Uterovesiculurus hamati* (Yamaguti) from *Sillago panijius; Stephanostomum bicoronatum* Stossich, from *Otolithoides biauritus; Opechona* sp. and *Lecithocladium excisum* (Rudolphi) from *Pampus argenteus; Genolopa bychowskii* Zhukov, *Opechona* sp. and *Lecithocladium excisum* (Rudolphi) from *Parastomateus niger; Lepocreadioides indicum* Srivastava from *Cynoglossus dubuis* and *Masculifer pacificus* Yamaguti 1938 and *Diploproctodaeum plicitum* (Linton), from *Torquigener oblongus.*

In addition, the larvae of cestodes are found in fishes with a few exceptions where adult forms, namely, *Gangesia pseudotropii* from *Pseudotrophis garua* and *Ligula* sp. from *Rasbora daniconius* have been reported from this region. The larvae of *Tentacularia macfiei* and *Cymnorhynchus gigas* from *Trichurus savala, G. gigas* from *Harpodon nehereus, G. gigas* and *T. ilisha* from *Clupea ilisha, G. gigas* from *Arius gagora* have been reported from these estuarine fishes. The adult of these larvae may be available with the birds or sharks, those who devour these fishes.

## ADAPTATIONS

The physical nature of the mangrove environment is severe, water and salt balance is one of the chief problems faced by the animal community occurring in mangroves. Desiccation is a possibility both in the intertidal mudflats and in the forested land. Reduced oxygen tension is another problem which frequently occurs in estuaries. Variable temperature often exacerbates these problems. High temperature increases the metabolic rate thus making life more expensive in terms of energy.

In the mangrove environment, mud-flat animals withstand both brackishwater of variable salinity and the rigours of intertidal life. In order to survive, it is not surprising to find that most of the animals inhabiting mangroves have evolved a number of adaptations to meet the environmental conditions. And, as such the mangrove fauna have undergone some anatomical, physiological and behavioural specialisations to cope with the hostile environment, to obtain food and escape from predation.

## A. ANATOMICAL SPECIALISATIONS

Most of the mangrove forest fauna belonging to mammals, birds, reptiles and amphibians do not show any anatomical specialisations to meet the environmental condition, while some have salt-secreting glands associated with the lacrymal glands. Aquatic reptiles occurring in the estuaries exhibit characteristically flattened tail which helps in wriggling movement in water.

Mudskippers, the most conspicuous fish fauna of the mangrove environment of Sundarban, have undergone distinct structural modifications so as to cling to twigs and leaves of mangrove when the tide rises. Main structural modifications are the fused pelvic fins which are so united by skin that they are able to assume suctorial function and facilitate the locomotion on land and climbing up on trees when needed. Other notable modifications are associated with the skeleton and musculature (Eggert, 1929; Harris, 1960; Macnae, 1968). The eyes of mudskippers, viz. *Boleophthalmus* and *Periophthalmus* spp., are also modified due to their amphibious mode of life. They are raised above the surface of the head and can be pulled down towards the buccal cavity simulating "blinking" as in higher animals. Further modifications are known to be present with the highly vascularised epithelium of the buccal cavity, the fins and the diverticula of the nasal sacs, which help in accessory respiration.

Among mangrove fauna, the crustaceans specially the crabs, have shown greatest anatomical specialisations in relation to feeding, respiration and vision. These crustaceans belong to a few highly specialised families viz. Grapsidae (Subfamily : Sesarminae), Ocypodidae, Portunidae and Xanthidae among crabs, while a few species of thalassinidean, alpheid prawns and the stomatopods have undergone certain specialisations. The grapsid crabs have developed strong jaws to feed on macroparticles, e.g. carrion, leaves and smaller organisms. The ocypodid crabs have weak jaws

but they have evolved elaborate mechanism to feed on organic matter from the substratum. They are usually adapted to substrate of specific praticle size, differing from species to species, perhaps to minimise the effects of interspecific competition. The tips of the chelae of most ocypodids are 'spooned' The first and second pair of maxillipeds are greatly modified particularly on the meropodite and bear special setae to act as sorting agents. Setae on the outer surface of the first maxilliped are modified to form a stiff brush. Whilst the setae on the inner surface of the second maxilliped are modified to have spoon tips or become feathery. Species of the genera *Uca* and *Dotilla* show such modifications in relation to feeding and picking up particles of particular size. They are very choosy in their demand on the substratum and thus limiting their distribution to a certain extent.

However, species of the genus *Sesarma* do not seem to be restricted to any particular grade of particle size of the substratum. In ocypodid crabs, the differences in setal modifications between the species of a sand-silt series are summarised by Ono (1965). It varies from 'spooned' to 'feathered' setae in various genera. The silt dwellers exhibit fewer setal modifications since they are, virtually, living in an 'organic soup'

Larger mudflat fauna respiring through the gills are always subjected to problems of exposure to the substratum. Fiddler crabs and sesarmine crabs solve this problem by two distinct methods (Verwey, 1930). One group, the 'pumpers' for example *Sesarma, Ilyoplax* and *Macrophthalmus* when in air, circulate the water in the branchial cavity through the gill chamber, up over the carapace and back down into the gill chamber again. In other groups -the non-pumpers, for example the fiddler crabs, *Uca,* etc. retain the water in the gill chamber and pass on a stream of air over and through this water.

In *Sesarma,* the pterygostomial region is strongly reticulated by raised ridges and setae which aid in spreading out water into a thin film over the reticulated region, thus helping in re-oxygenation of water of the branchial cavity. In *Uca,* the gills are reduced and the gill chamber is partitioned into an upper, vascularised chamber, functioning as a lung, and a lower, more normal gill chamber. A continuous stream of air is passed to reoxygenate the water in the gill chamber. Loss of water through evaporation is being minimised by the possession of very small inhalent and exhalent apertures. However, replenishment of water is effected, when needed, as the burrows of these crabs reach to a lower level than the water table.

Finally, most ocypodids have long ocular peduncle. The eyes are borne at the tip of the elongated stalk which project well beyond the lateral margins of the carapace. The most important advantage associated with such structural modification is the avoidance of predators (Barnes, 1968). The crabs can bury themselves well below the surface of the mud, leaving only the tips of the peduncles at or above the mud surface.

## B. PHYSIOLOGICAL SPECIALISATION

The physiological adaptations are associated with the salinity of the external medium. In most of the estuarine crustaceans, the permeability of the body surface is reduced so that the power of osmotic and ionic regulation may be achieved. The active uptake of environmental ions and the production of a hypotonic urine become pronounced in some species. The estuarine polychaetes and molluscs have poor capacity of osmoregulation. The individual body cells of these animals either tolerate wide range of internal concentration or to some extent regulate their own cell fluid. In euryhaline animals, the intracellular isosmotic regulation allows the cells to regulate the levels of inorganic ions to the level required. The concentration of free animo acids has been extensively studied (Rankin and Devenport, 1981) in both euryhaline crustaceans and stenohaline echinoderms. It has been revealed that the total concentration of free amino acids is positively correlated with salinity. Osmoregalators are 'better' estuarine organisms than osmoconformers as they have wide powers of tolerance coupled with intracellular isosmotic regulation in some species of *Arenicola, Mercierella* and *Macoma.*

## C. BEHAVIOURAL SPECIALISATIONS

Many behavioural adaptations can be observed in a large number of mangrove fauna. Burrowing habit is one such most widespread and most primitive behaviour in use. The burrows help the burrowers to remain hidden from a number of potential predators. It also helps a species to inhabit regions of comparatively constant or only slowly changing salinity. This allows easing the strain of osmoregulation and acclimation to salinity changes. Besides provision of a refuge, any burrow may be used as a centre of territorial behaviour and as a necessity to mating and feeding.

Many burrowing grapsids and other crustacean burrowers are dependent on water table. Their burrows are so constructed that after

reaching the water table the burrows become somewhat enlarged to form a pool in which the crustaceans, mainly the crabs can wet their gills. Species of thalassinid and alpheid prawns make their burrows in the mud. The burrows of most thalassinids are U - shaped or having a single burrow with several side arms. It seems that the burrows are conditioned to the feeding techniques of these anomurans.

In mud-skippers, the mating pairs display strong sense of territorial behaviour centred around the nest burrow. Males select a suitable site, build the burrows by scooping up mud by mouth and finally each attracts a female by their characteristic sexual display so that mating pairs are formed. Males vigorously defend the territory from intrusion by other males and even the crabs. Fighting and confrontation are common in driving off rivals to retain the possession of the female as well as while they are feeding.

In the Sundarban, tigers are capable of leading an almost amphibious life and they are good swimmers. It is speculated that the tigers in the Sundarban do not have territories owing to the obliteration of urination marks by the tidal water. That is why they are found to freely cross the wide rivers, of about a km or two in width. The association of spotted deer and Rhesus monkey is quite common in the Sundarban. The troops of Rhesus monkey (*Macaca mulatta*) climbing in Keora trees (*Sonnertia apetala*) often cause a good quantity of leaves to fall on the ground. These leaves are consumed by the spotted deer grazing under monkey-inhabited keora trees. The monkeys also warn the deer about the presence of tigers by their alarm signals. But it is not known whether any sort of dependency of the monkeys exists with the deer population except the occasional flee away alarm of the deer in response to human intrusion in the jungle. These leaf-eating monkeys are also well adapted to crab-eating (Mukherjee and Gupta, 1985). They often lick dew drops to quench their thirst for freshwater when other sources dry up. The spotted deer can be seen to drink saline water and secret salts through salt secreting glands associated with the lacrymal glands.

In the mangrove habitat, the feeding habit of animals has been found to have changed. Thus, in the diet of tiger fish, crabs and even water monitors have been included. The wild boars (*Sus scrofa*) which practically feed on underground tubers, prefer eating dead fishes, crustaceans, molluscs and sea-turtle eggs in the Sundarban. The large Indian Bandicoot, *Bandicoota indica* have secondarily adapted themselves to take fish, snails, etc.

Many estuarine animals have the powers of habitat selection. They react to chemical and mechanical properties of the sediment, etc. and are substratum specific. For example, the polychaete and barnacle larvae do not metamorphose until, of course, within certain limits, suitable substratum is reached.

Several species of detritus feeder exhibit biorhythms in their feeding behaviour. They are active mainly at night. This reduces the changes of being taken by predators. Most of them are especially active during periods of tidal influx.

The other behavioural specialisations are concerned with the breeding migrations of the more mobile decapod crustaceans inhabiting estuaries. Many decapod species can migrate to adjacent sea on the onset of reproductive season. This sort of breeding migration is initiated by a change in salinity of the medium. Similar short time scale migrations, unrelated with reproduction, are also common in many decapods. They migrate up and down the estuaries with the state of the tide. In many crustaceans and decapods (e.g. shrimps, prawns and crabs and non-decapods e.g. mysids), larval life is spent in the sea, after which young ones migrate back into estuaries.

Life-history strategies are interestingly evolved in different groups of estuarine animals to tide over the unfavourable environments. The production of planktonic larval stages is one such phenomenon. As a result the free-living and free-swimming larvae of many of the marine relatives of estuarine animals may passively be carried away into the adjacent sea. While the larvae of some polychaetes instead of inhabiting the overlying water mass, live within the parental burrow system. Many mangroves species are short lived, often with annual life-span. They breed only once and then die i.e. they are semelparous species. These animals usually devote a large proportion of their available energy to the production of eggs or larvae and hardly little is invested in growth. Still other species are known to invest energy in the provision of yolk for their eggs. The brackishwater animals find it advantageous to produce few offspring each with its own food reserves which would allow the young stages to withstand potential competition for food immediately after an environmentally induced population crash (Barness, 1984).

## DISCUSSION

The role played by the mangrove in the ecosystems of the world is being increasingly understood today. As a nutrient filter and synthesizer of organic matter, mangroves create a living buffer between land and sea. According to Teas (1976) mangroves are valuable for shoreline protection and stabilisation of soil as well as the habitat. The rich and diversified life of this ecosystem is due to high energy production capacity of mangroves especially towards estuarine and marine fertility (Heald and Odum, 1970; Macnae, 1974). The various ecosystems are the nursery grounds of many economically important fish and shellfish viz., crustaceans and molluscs (de la Cruz, 1976, 1979).

Mangroves attain their greatest diversity and luxuriance in the Sundarban and cover 424, 124 hectares along the estuaries and coastlines of both South and North 24-Parganas districts, West Bengal. In this ecosystem the diversified habitats like the tree, soil and water are occupied by different groups of organisms (Table 3) exposed to different sets of environmental conditions. The animals inhabiting the intertidal region exhibit constant interaction with variable salinity, muddy substratum and periodic tidal flush and are unique to this habitat. The fauna, as a whole, have greater mobility to choose their habitat, unlike the plant community. Hence, the number of species representing the fauna (Table 3) is very much greater than the number of plant species occurring in this area.

Table 3. Mangrove fauna - their habits and habitats.

| Taxon | No. of Species | Forest | | Mudflats | Estuary | |
|---|---|---|---|---|---|---|
| | | Aerial or Arboral | Ground or Soil | Benthos | Plankton | Nekton |
| Porifera | 1 | | | + | - | |
| Cnidaria | 5 | - | | + | + | + |
| Ctenophora | 1 | - | - | | + | - |
| Platyhelminthes | | | | | | |
| Turbellaria | Undetermined | - | - | + | - | - |
| Rhynchocoela | Undetermined | - | - | + | - | - |
| Aschelminthes | | | | | | |
| Rotifera | 5 > | | | | + | |

| Taxon | No. of Species | Forest | | Mudflats | Estuary | |
|---|---|---|---|---|---|---|
| | | Aerial or Arboral | Ground or Soil | Benthos | Plankton | Nekton |
| Nematoda | 2 > | | | | | |
| Chaetognatha | 2 | - | - | - | + | - |
| Ectoprocta | 3 | - | - | + | - | - |
| Brachiopoda | 1 | - | - | + | - | - |
| Mollusca | | | | | | |
| Gastropoda | 51 | + | + | + | - | - |
| Bivalvia | 39 | - | - | + | - | - |
| Cephalopoda | 4 | - | - | + | + | + |
| Annelida | | | | | | |
| Polychaeta | 39 | | | | | |
| Oligochaeta | 6 | - | + | + | - | - |
| Hirudinea | 3 | - | - | + | - | - |
| Echiurida | 2 | - | - | + | - | - |
| Sipuncula | 1 | - | - | + | - | - |
| Arthropoda | | | | | | |
| Crustacea | | | | | | |
| Branchiopoda | 3 > | - | - | - | | Pelagic |
| Copepoda | 44 > | - | - | + | | Pelagic |
| Ostracoda | 1 > | - | - | - | | Brackish water from |
| Branchiura | 1 | - | - | - | | Parasitic in brackish water fish |
| Cirripedia | 15 | - | - | + | - | - |
| Malacostraca | 105 > | - | - | + | + | + |
| Insecta | 154 > | + | + | + | - | - |
| Arachnida | 35 > | + | + | + | - | - |
| Echinodermata | 14 | - | - | + | | Pelagic |
| Hemichordata | 1 | | - | + | - | - |
| Chordata | | | | | | |
| Chondricthyes | 16 | - | - | - | - | + |
| Osteichthyes | 125 | - | - | - | - | + |

| Taxon | No. of Species | Forest | | Mudflats | Estuary | |
|---|---|---|---|---|---|---|
| | | Aerial or Arboral | Ground or Soil | Benthos | Plankton | Nekton |
| Amphibia | | | | | | |
| Anura | 8 | + | + | - | - | - |
| Reptilia | | | | | | |
| Chelonia | 12 | | - | + | - | + |
| Squamata | 44 | + | + | + | - | + |
| Crocodilia | 1 | - | - | + | - | + |
| Aves | | | | | | |
| Resident Species | 111 | + | + | + | | Water birds |
| Migratory Species | 50 | + | + | + | | Water birds |
| Mammalia | | | | | | |
| Insectivora | 1 | - | + | - | - | - |
| Chiroptera | 11 | + | - | - | - | - |
| Primate | 1 | + | + | - | - | - |
| Pholidota | 1 | - | + | - | - | - |
| Rodentia | 7 | + | + | - | - | - |
| Cetacea | 5 | - | - | - | - | + |
| Carnivora | 12 | + | + | - | - | - |
| Artiodactyla | 2 | - | + | - | - | - |

The heavy rain during monsoon sometimes bring down the salinity to the lowest level even at the mid-estuaries and the organisms at this zone are supposed to change both in number and in diversity of species during this time.

Though it is very difficult to characterise the mangrove fauna as a whole, Ekman (1935) has stated that the mangrove fauna is characterised by its low species diversity but having larger populations. On the other hand, Fisher (1940) expressed that the faunal component should be considered as organisms originating from mudflats as well as from general brackishwater. The faunal composition of mangroves can not be taken as specific nature as stated by Sandison and Hill (1966). While studying the Indo-West Pacific forest and mangrove fauna, Macnae (1968) stated that it is difficult to say which species are confined to mangrove and do not occur in other habitats; on the other hand, the same species may be available in various mangrove

ecosystems within the same ecological region. Day (1974) however, stated that if the mangrove formation is large, the fauna of that area will be distinct even though some of the species may simultaneously occur in non mangrove habitats.

As stated earlier, in this transitional zone, the marine, terrestrial and brackishwater elements form the main component of the mangroves. Some of the species, however, become capable of tolerating the odds and evils of the area and adapt themselves well in this particular ecosystem.

Basically the mangrove ecosystem of Sundarban can be considered as an estuarine ecosystem. And, as such majority of the mangrove fauna are virtually, estuarine animals (Table 3.). They differ in habits and in the preference of habitats and even one group of animals may exhibit or occupy two or more habits and habitats, respectively. Among the mangrove fauna, the non-resident or visiting fauna are very large and come from both terrestrial and aquatic zone. The precise distribution of each species within the mangrove habitat is determined by factors such as salinity, soil type, vegetation, etc. There are special habitats too, viz., rot-holes of decaying trees, mud-lobster mound, etc. which are inhabited by distinctive animal communities of their own (Macnae, 1968; Macintosh, 1984).

Besides aquatic fauna, in the faunal assemblage of the mangrove ecosystem, it has been observed that the epifauna form the main bulk in comparison to the infauna. Most of the fauna are detrivorous excepting a few infauna which are omnivorous.

Pant *et al.* (1980) did not get any positive corelation between the phytoplankton biomass and benthic animal populations in the mangroves of Goa. But the detritus base food web is very much reflected due to the dominance of detritus feeders in this habitat.

Phytoplankton (as primary producer) and the different microbes associated with decomposition of leaflitters, are providing food in this ecosystem. The zooplankton, benthos and other terrestrial and aquatic vertebrates and invertebrates act as consumers in which tiger is occupying a unique position, being at the top of the pyramid in this foodchain.

The terminal position of the tiger in the aquaterrestrial food chain of the Sundarban mangrove ecosystem and a highly simplified picture of the whole

food web are shown in Text fig. 5. It displays the complex manner in which the various components are linked together and exhibit the import or the export of a large amount of fixed energy in the form of detritus from the estuary to the adjacent sea. Though the diagram shows the fundamentals concerning the important pathways of energy flow, it is difficult to connect the line showing tigers as the consumer of fishes and crabs from the intertidal mudflats and estuary.

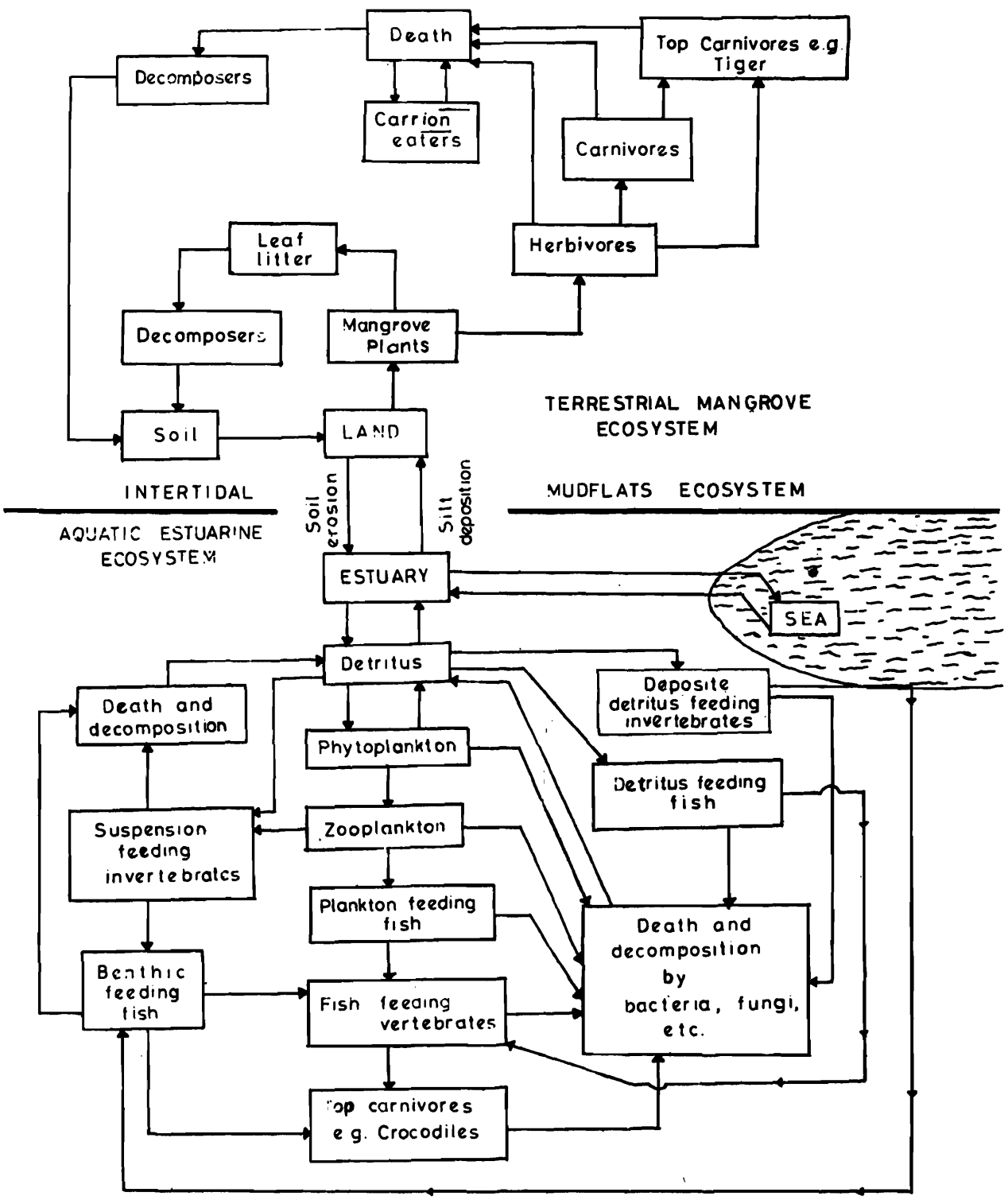
With so many environmental stresses, the tiger, a unique species occurring only in the Sundarban mangrove ecosystem of the world, has adjusted nicely and its gradual increase in population within a decade or so under special protection justifies our contention. The initial population of tiger was 135 in 1973 when the Project Tiger started and in 1979 the total number of tiger reached to 205 and according to 1983 census the number increased to 264.

In order to provide food to these tigers the domestic pigs from outside are being released in the forest. Due to this introduction and release of pigs, a feral type of pig population has been developed within the forest which is likely to interfere with the preservation of genepool of wild boar of this area.

This is also true for the Jungle fowl population of this forest. A sizeable population of domestic fowl is released by the local people inside the forest as offer to the Deity 'Bonobibi' - the Goddess of the forest, so that these people may not get any trouble during their stay inside the forest, specially from the tiger. As such a feral population of fowl has developed.

Moreover, amongst the migratory birds, several species, namely, Common Sandpiper, Wood Sandipiper, Green Sandpiper, Scaup duck and Turnstone have been observed in this area even in premonsoon and monsoon months, when they ought to have left the place as per schedule. Whether these birds are not being able to take a long and sustained flight they require for their return journey or becoming adapted to this environment is still not clear.

The occurrence of King Cobra and Python in this forest is now doubtful. Not even once during their several visits the authors came across a single example of these two species of snake. For the last authentic record of King Cobra from this region we may have to go back as late as forties or so (vide




Text-fig. 5. Food web within mangrove environment - an Aqua-terrestrial ecosystem.

Gupta, 1964). Recently, the Olive Ridley turtle has drawn the attention of naturalists and scientists. At the time of breeding, a sizeable population of this turtle is being caught and disposed off for the different markets. The demand of their meat for local consumption has grown day by day. As a result an alarming situation has arisen regarding their population. The authorities have, however, timely interrupted the matter for protection and placed this turtle under Schedule I of the Indian Wildlife (Protection) Act. Simultaneously, the collection of eggs and artificial rearing are being continued by the Project Tiger authority. Sanyal (1983) located 39 nesting areas of Olive Ridley turtle at Mechua - Saimari and Kalash Islands. Incidentally it may be mentioned that these islands are not inhabited by Water Monitor or Wild Boar who devour the eggs of this turtle and probably due to which the turtle has chosen these islands for breeding.

At Sajnakhali, artificial breeding of this turtle is being carried out and the hatchlings are released in the sea. Saha (1984) stated that about 51% hatchings from sand pits were obtained in 1983 and 22% in 1984.

The sweet water tanks and pools inside the mangroves have attracted the Skipping Frog, *Rana cyanophlyctis,* usually found in the brackish water pools of the reclaimed area of Sundarban and recently an increase of their population within forest has been observed. This species is experiencing isolation and the future possibility of growing to a distinct population can not be ignored.

Other than the edible fishes connected with the fishery of this region, a sizeable population of trash fishes are also being caught to meet up the requirements of poultry feed, fish meal and manure. A large number of molluscan shells, namely, *Meretrix, Telescopium* and *Crassostrea* are being collected from this region and utilised for poultry feed and lime industry, which has a direct bearing on the ecology of the area as a whole.

Report on the damage caused by the teredinid wood borers to plants have been made by several authors. Roonwal (1954) mentioned that the living plants were found to be infested by these borers and numerous galleries were formed causing uprooting or breaking of the trees during storm. Rajagopal (1964) also studied the borers from Sundarban and stated that the living trees like *Avicennia, Carapa, Excoecaria, Aegiceras, Xylocarpus* and *Heretiera* were infested by these borers. He has also recorded isopod borers, *Sphaeroma* sp. from this region. Similarly,

Santakumaran (1986) also observed the infestation of these teredinid borers in living trees at Goa. However, no infestation of teredinid borers in living parts of plants was seen by us but in some instances stilt roots of *Bruguiera* sp. were found to be attacked by them as also the piles of wooden jetty inundated by tidal flush.

Out of all the ecotonal zone provided by the mangrove, the intertidal mudflat is unique so far as its faunal component is concerned. The diversification, species composition and their zonation is interesting from ecological, physiological and behavioural point of view. They are known to be characterised by the horizontal zonation in addition to the vertical zonation in this ecotonal zone.

Misra and Choudhury (1986) discussed the horizontal and vertical distribution of polychaetes of this region and stated that even the marine forms viz., *Diapatra, Phyllodoce, Lumbrineris, Glycera* and *Prionospio* were available throughout the length of the estuary extending upto the upper reaches since there is less supply of freshwater inflow in these estuaries. From the subtidal region, *Ancistrosyllis, Laonome,* and *Stenaspis* were recorded. In between midwater mark and subtidal region, *Diapatra, Glycera, Namalycastis* and *Lumbrineris* were encountered. A poor population of capitellids was recorded from the zone above midwater mark.

Mandal and Misra (1986) discussed the vertical distribution of macrobenthos and noted that the lower zone is occupied by *Diapatra* (Polychaete), *Saccoglossus* (Hemichordate), *Meretrix* and *Dosinia* (Bivalve molluscs), *Pelocoetes* (Sea anemone) and a few species of gobiid fishes. The middle zone is characterised by *Dotillopsis* (Brachyuran crab), *Edwardsia* (Sea anemone), *Assisminea* (Gastropoda) *Macoma* (Bivalvia) and occasionally with *Uca* sp. (the Fiddler crab). The upper zone is occupied by *Sesarma* (Brachyura) *Littorina* (Gastropoda), *Pharella* (Bivalvia), and *Phascolosoma* (Sipunculida) and *Uca* spp. (Brachyura).

Mandal and Misra (loc cit) further stated that the filter feeders like the bivalves are rare in mangrove-fringed muddy area probably due to high turbidity of the estuarine water of this area which may possibly hinder their filteration process. But the deposit feeders are abundant in this area due to adequate quantities of detritus. The presence of *Phascolosoma* (Sipunculida) in mangrove belt may be attributed to the optimum range of temperature variation in this zone preferred by this organism.

Chakraborty and Chaudhury (1986) studied the distribution of fiddler crabs in Sundarban and found that sediment with more sand particle is the deciding factor for their distribution. *Uca acuta acuta* (= *Uca roseus* Tweedie) is widely distributed. The root-mat of mangrove vegetation with mud is preferred by *Uca triangularis*. The occurrence of *Uca dussumieri* in infralittoral zone of the area devoid of mangrove is interesting. They are incapable of tolerating longer exposure too. The restricted distribution of *Uca triangularis* and wider distribution of *Uca acuta* (= *U. roseus*) also corroborate with the observations made by Mandal and Misra (1986).

Though it is difficult to generalise the zonation in this mangrove belt but for a particulr animal the zonation is distinct in this area. The hemichordate, namely, *Saccoglossus* sp. is invariably found within the subtidal level in between ELWN and ELWS. It has been observed that if the area of exposure is wide and flat the animal zone becomes wide; if it is steep or narrow the concentration of animal is restricted to the shortest possible area. A thick concentration of sea-anemone has been observed at Namkhana in Hatania-Duania river bed at lower zone within a narrow space. The polychaete-decapod zone at Canning in Matla river bed is very wide at the middle zone.

In the food chain the role of zooplankton need not be explained. The recent findings have brought about a wealth of information regarding their distribution, faunal component and seasonal variation in different coastal water bodies of India. Bhunia and Choudhury (1981, 82) studied the zooplankton in the Creeks of Sagar Island and recorded the following groups, namely, Copepods, Chaetognaths, Mysids, Lucifers, Amphipods, Ostracods, different types of medusae, larvae of decapods and cypris of *Balanus*. Nandy, Bagchi and Muzumder (1983) noted the remarkable change in the plankton population during pre and post Farakka discharges in the Hooghly estuaries. A significant improvement with increases of density in planktonic population has been observed 3-5 times more in the post Farakka discharge in the upper region whereas in the lower Hooghly estuary not much significant changes have been noticed except the predominance of marine forms.

Baidya and Choudhury (1985) while studying the fluctuation of zooplankton population in Hooghly estuary found that the number of copepods increases during the period of high salinity (Premonsoon months)

and the number declines during low salinity season specially during monsoon months which corroborates with the findings of Rao *et al.* (1981). In the lower stretch of Hooghly estuary, Bhunia and Choudhury (1981), Baidya and Choudhury (1984), Sarkar, Singh and Choudhury (1986) also noted bimodal distribution of zooplanktons, one peak in March - April and the other in November - December.

Sundarban as a whole has suffered a lot and still continues to suffer due to the reclamation of the forest land to meet the evergrowing demand for human settlement and agriculture. In order to fulfil this demand innumerable barriers have been made by erecting "Bundh" in the criss-crossed rivers, previously well connected all through, have interferred with the natural equilibrium of this ecosystem. The usual flushing of tidal water and natural inundation have greatly been affected resulting in quick succession or shifting of plant communities also (Sanyal *et al.,* 1984). Within the span of 100 years the animals like Rhino, Wild buffalo, Swamp-deer and Barking-deer have disappeared from this region due to human interference and unusual habitat destruction. Injudicious exploitation of forest wealth by the local people is a burning problem of the Sundarban.

With the increase of urbanisation, industrialisation and modernisation of agriculture, the Sundarban mangrove ecosystem is subjected to environmental stresses due to industrial effluents, domestic sewage, pesticides, herbicides and oil which play a major role in polluting this sensitive ecosystem.

Since the Sundarban estuarine ecosystem is directly connected with river Ganga and is close to one of the largest metropolis Calcutta, it is high time to think about a management scheme of this ecotonal zone, acting as cushion or buffer in between the mighty sea and the human habitation. Any imbalance in nature is reciprocative and irrational utilisation without proper management for short term benefit will ultimately drastically affect the long-term benefit. It is not only for the animals and their associates but also for our own mortal survival, this part of biosphere needs immediate attention for protection, conservation and production intensification primarly without cutting down mangrove trees.

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] PLATE I

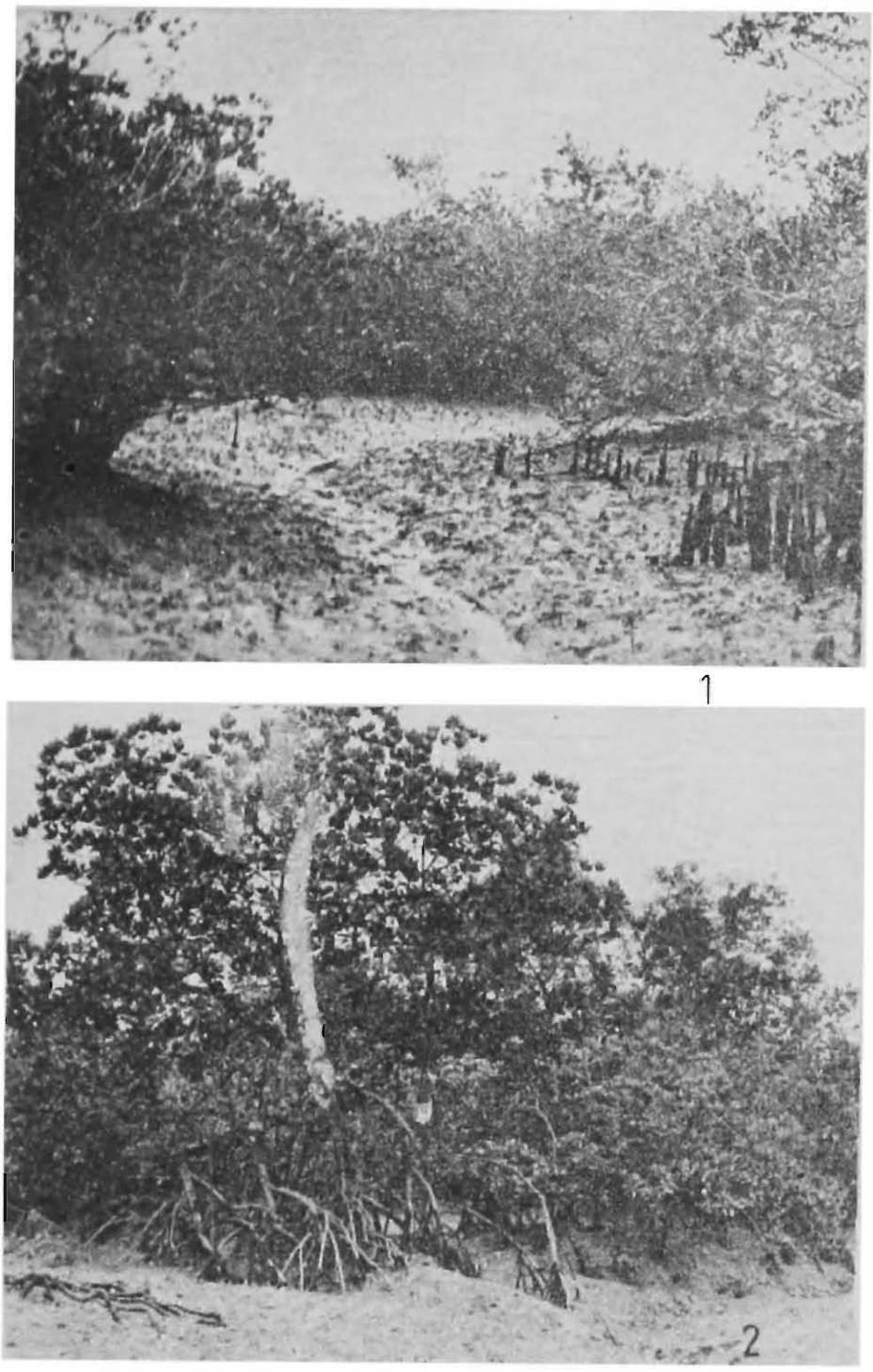


Fig. 1. A typical mangrove habitat, showing forest floor with a narrow creek (*Jhora*).
Fig. 2. A stilt root of *Rhizophora apiculata*.

PLATE 2

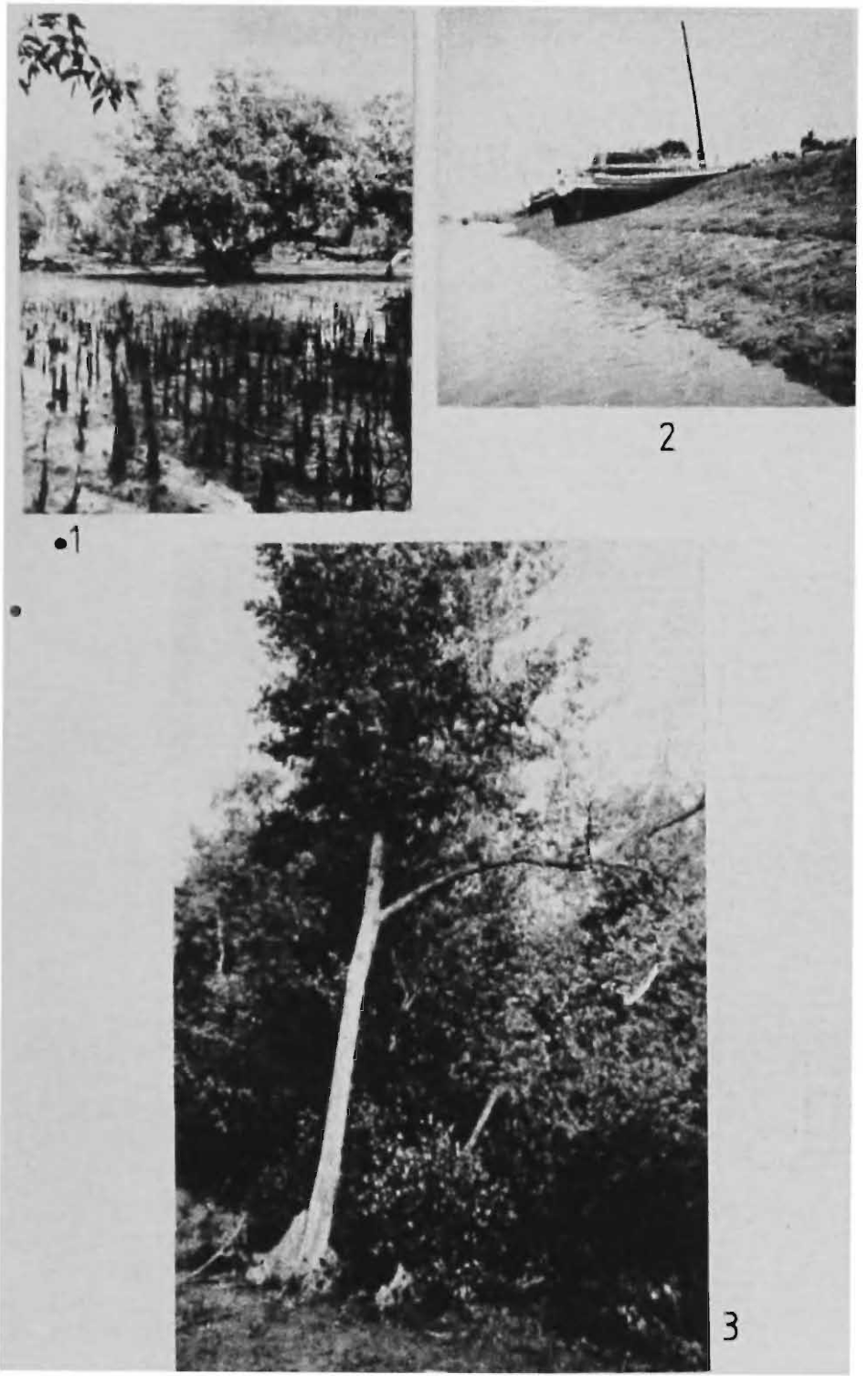


Fig. 1. Pneumatophores of *Sonneratia apetala;* Fig. 2. Exposed mudflat of Hatania-Duania river at Namkhana; Fig. 3. Sundari tree, *Heritiera fomes* in Sundarban.

## PLATE 3

Vivipary in *Bruguiera gymnorrhiza*

## PLATE 4

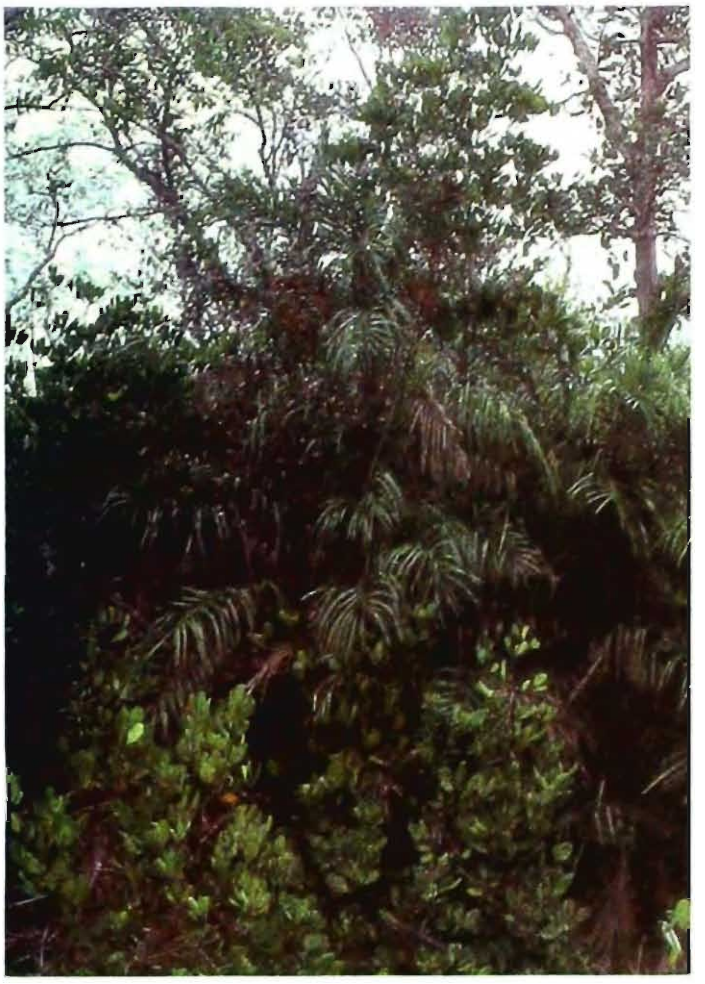

**Fig. 1. A small creek** *Nypa fruticans* on the bank; Fig. 2. *Phoenix paludosa* **with its ripe fruits.**

PLATE 5

Fig. 1. Whitecollared Kingfisher, *Halcyon chloris* inside the forest, Fig. 2. Sajnakhali Bird Sanctuary— an overview.

## PLATE 6

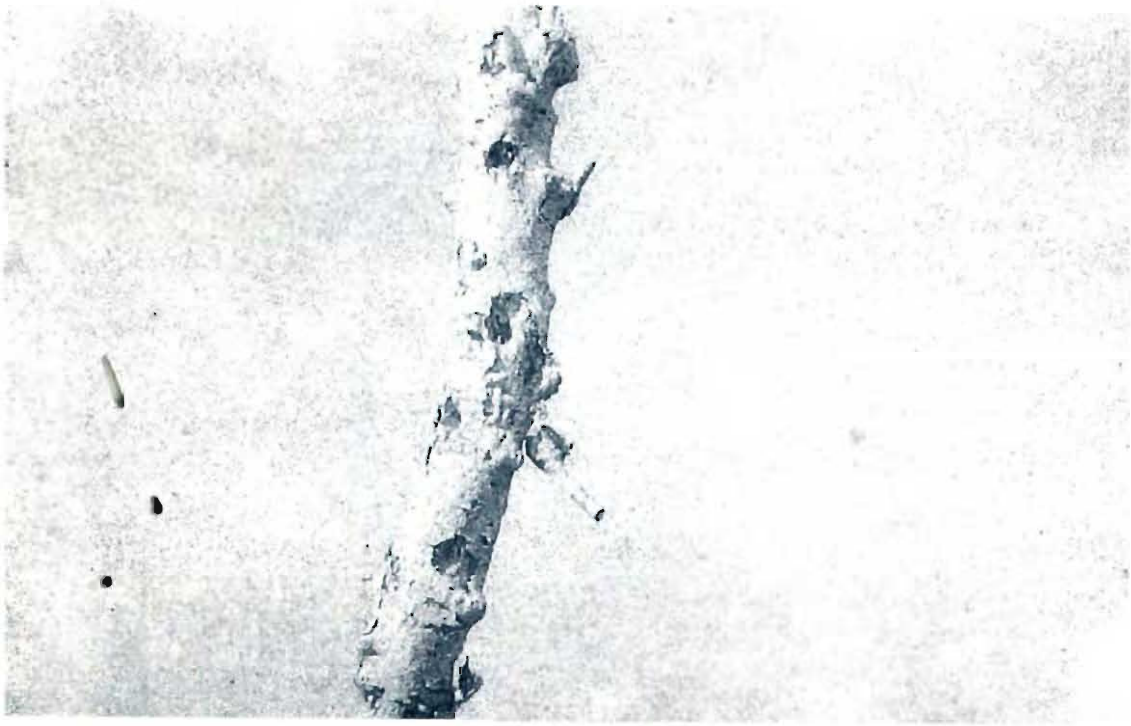

Fig. 1. A tree with a number of holes formed by insect borer, Fig. 2. Spotted deer, *Cervus axis* near Haldi Watch Tower inside the forest (Sundarban Tiger Reserve).

PLATE 7

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Fig. 1. Common King Crab, *Carcinoscorpius rotundicauda,* Fig. 2. *Balanus* sp.

PLATE 8

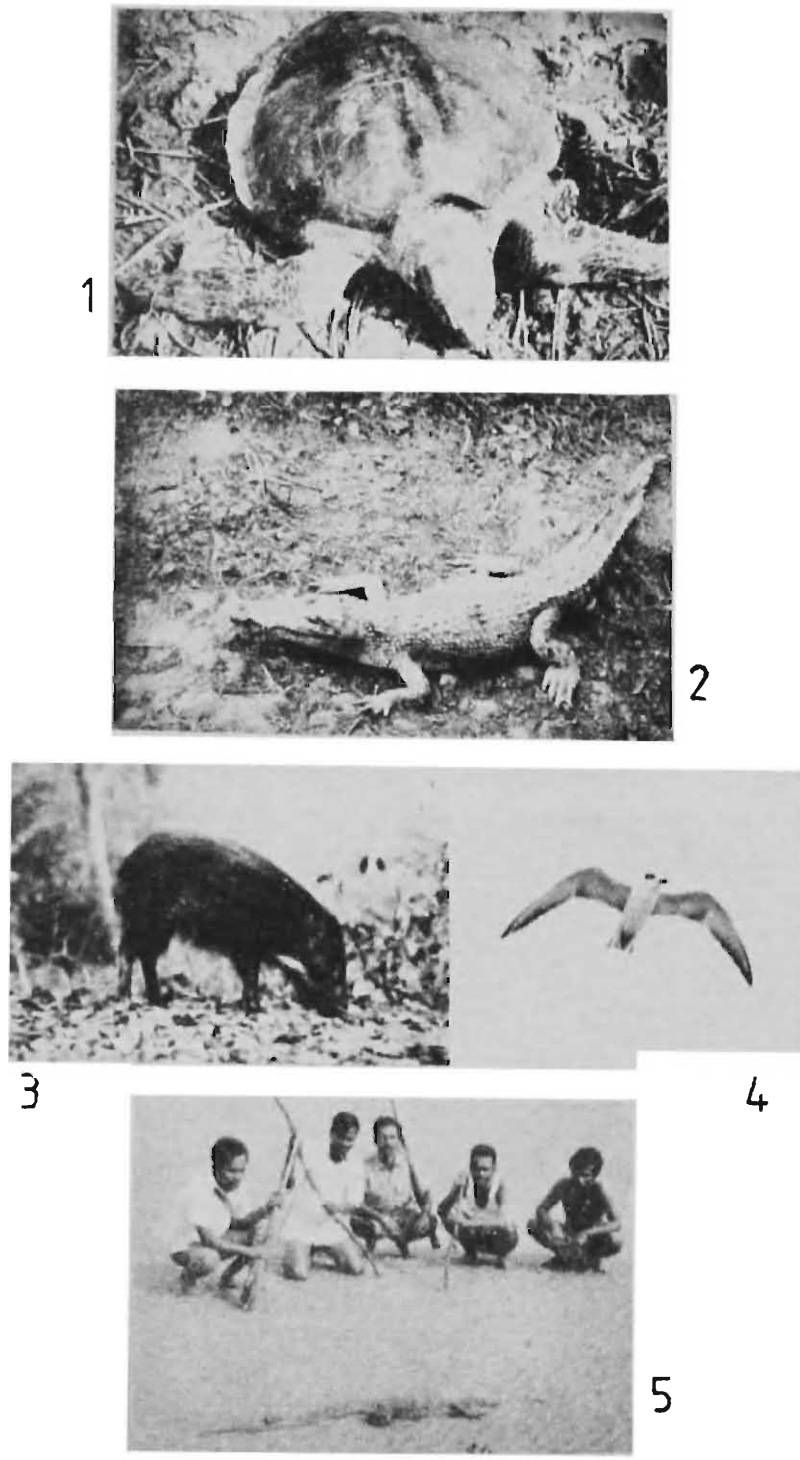



Fig. 1. Olive Ridley Turtle, *L. olivacea,* Fig. 2. *Crocodylus porosus* in Lothian Island, Fig. 3. Wild boar, *Sus scrofa* searching for food in Sundarban, Fig. 4. Little Tern, *Sterna albifrons* flying over the Matla river near sea, Fig. 5. *Varanus salvator,* being watched by members of a survey party.

PLATE 9

Fig. 1. Eel fish at Matla river bed, Fig. 2. *Telescopium telescopium* at Matla river bed.

PLATE 10

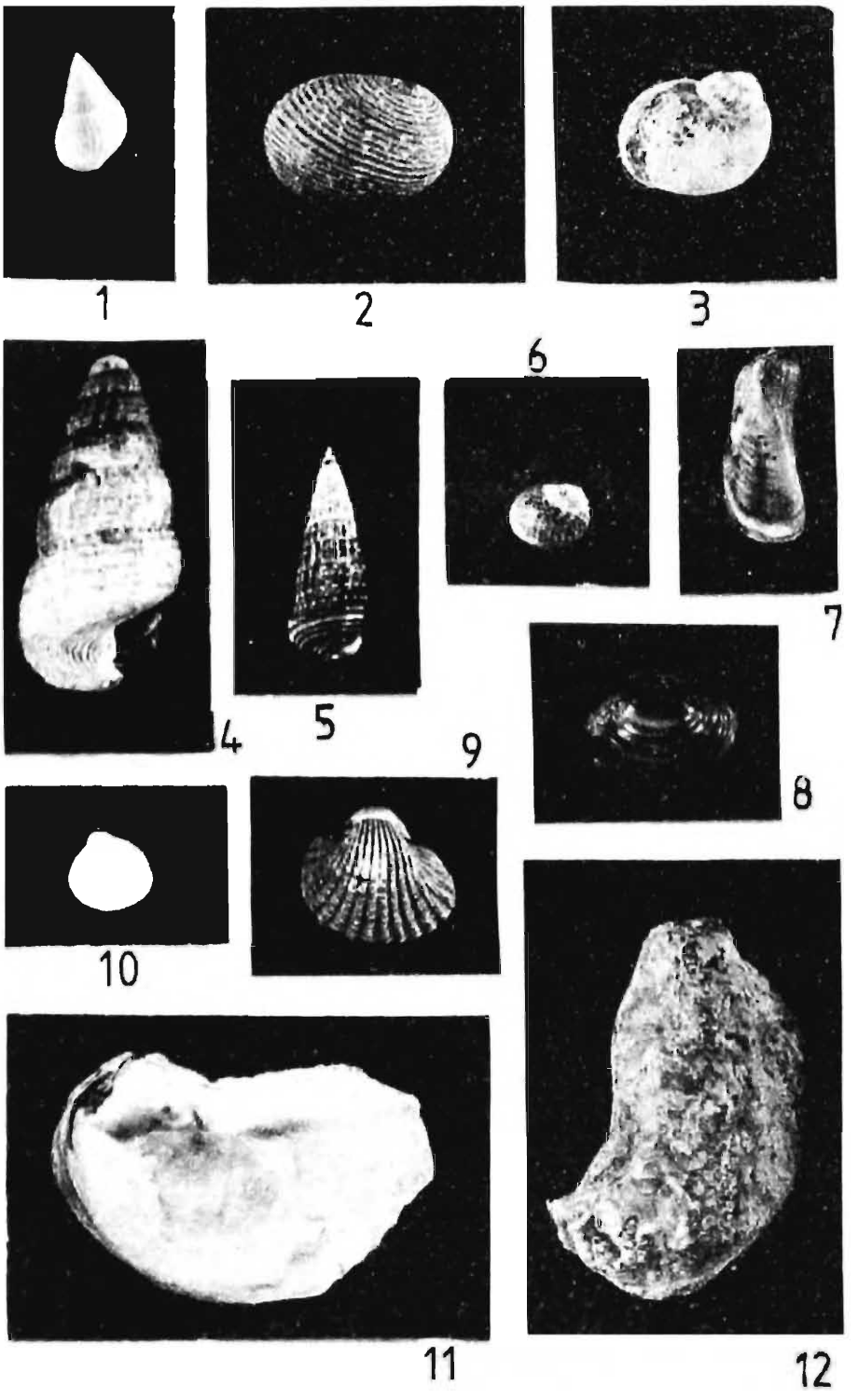
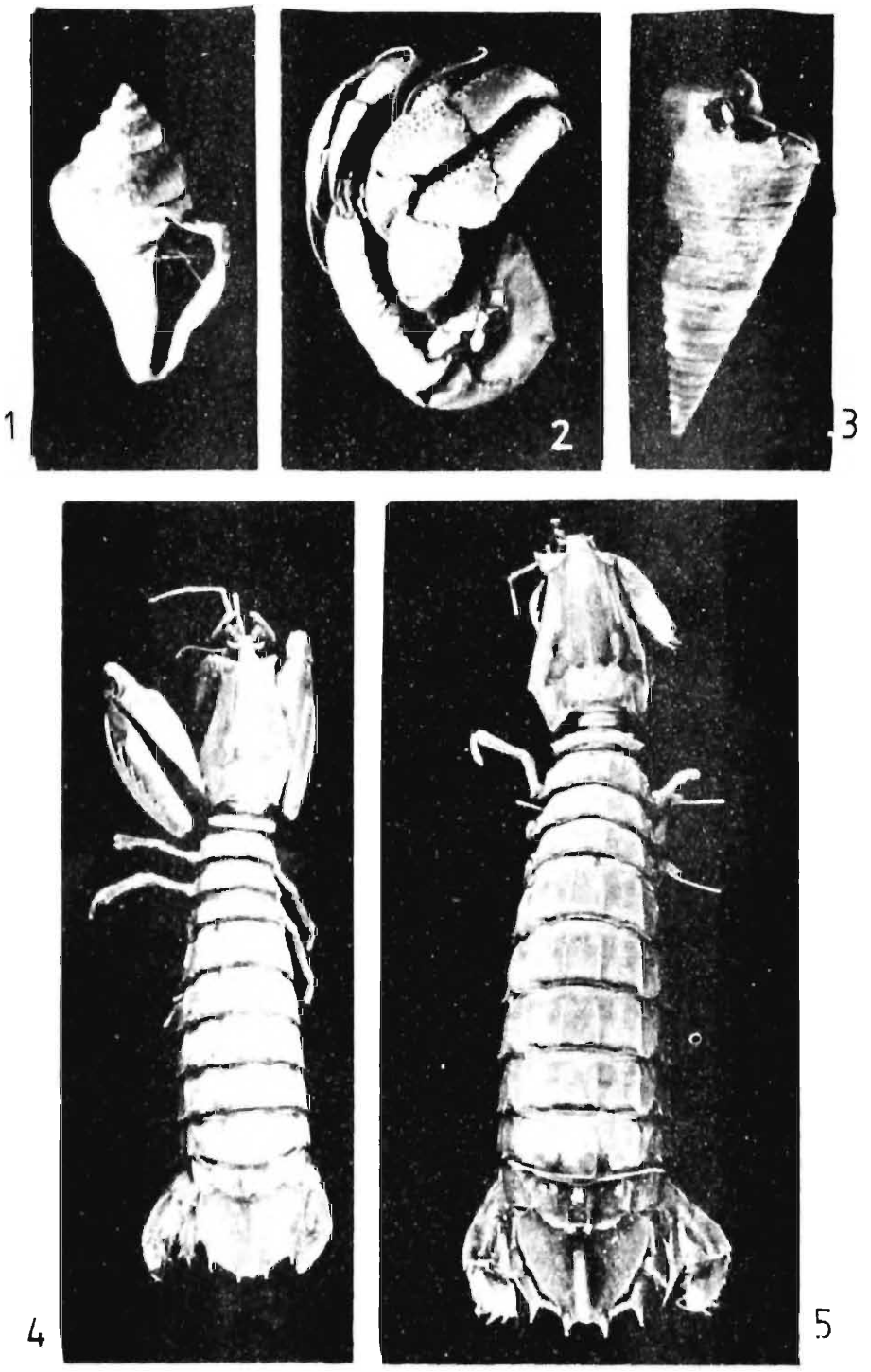


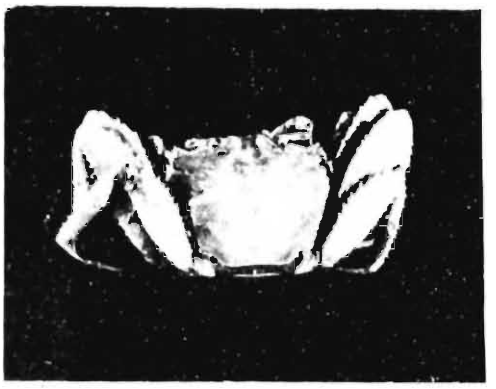

Fig. 1. *Littorina* sp., Fig. 2. *Nerita* sp., Figs. 3 & 6. *Natica* spp., Fig. 4. *Cerithetdia obtusa*, Fig. 5. *C. singulata*, Fig. 7. *Modiolus* sp., Fig. 8. *Meretrix meretrix*, Fig. 9. *Anadora granosa*, Fig. 10. *Dosinia trigona*, Figs. 11 & 12. *Crassostrea* sp. shell, inner and outer sides.

PLATE 11




Figs. 1 & 3. Hermit Crab, *Clibanarius padavensis* inside the shell, Fig. 2. Hermit Crab, *Coenobita cavipes* after taken out from the shell, Fig. 4. *Squilla scorpio,* Fig. 5. *Squilla raphidea.*

PLATE 12



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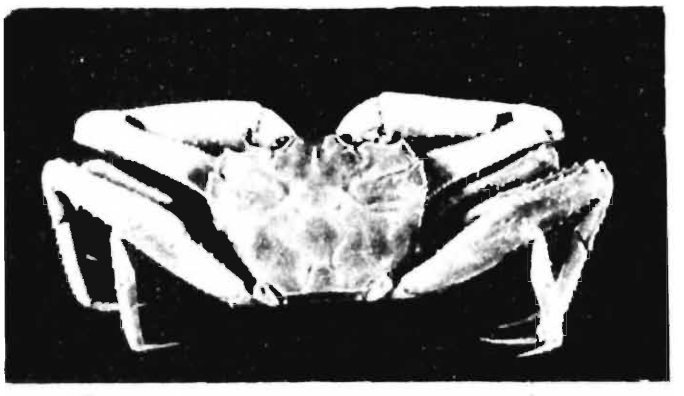

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Figs. 1 & 2. *Metaplax crenulata* ♂ ♀ Fig. 3. *Sesarma bidens*, Figs. 4 & 5. *Uca roseus* ♂♀, Fig. 6. *Thalassina anomala.*

PLATE 13

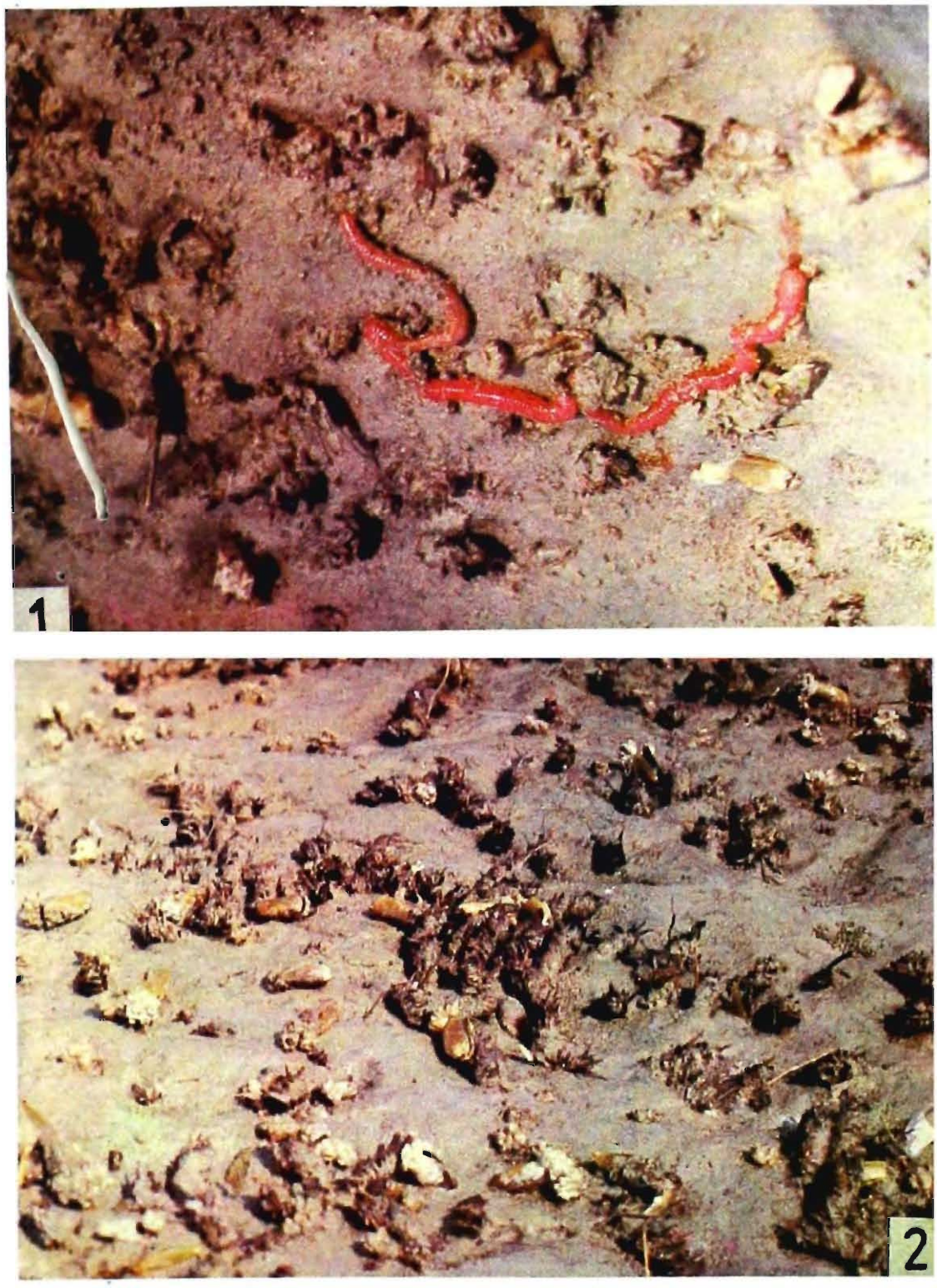


Fig. 1. *Lumbrineris polydesma* at Matla river bed, Canning, Fig. 2. Tubes of *Diapatra* sp. along with shells of *Modiolus* sp. at Matla river bed, Canning.

PLATE 14

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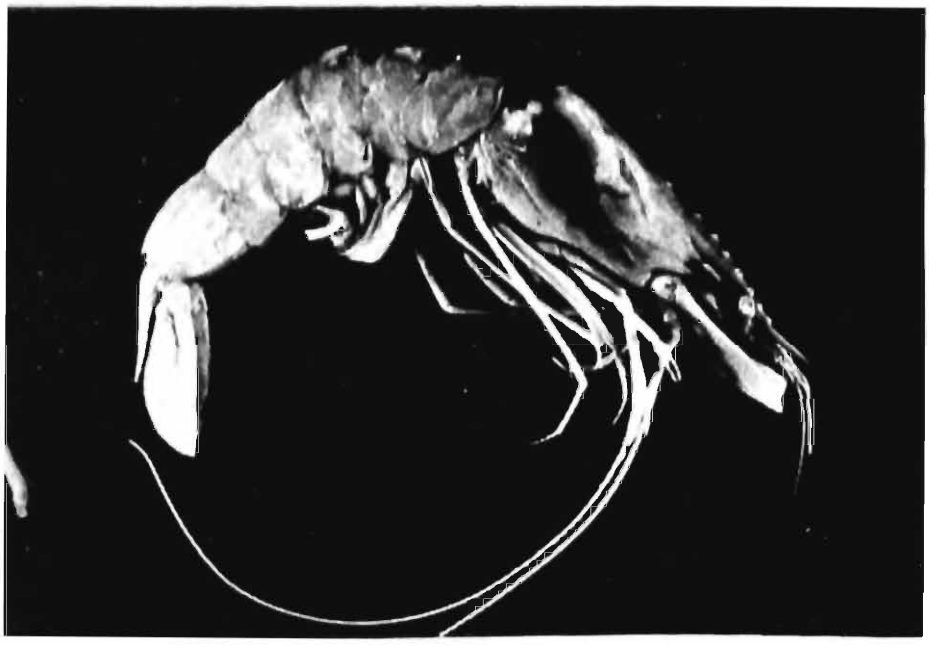
Fig. 1. An echiurid, *Anelassorhynchus dendrorhynchus*. Fig. 2. A common tubiferous polychaete, *Diapatra cuprea*.

PLATE 15



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2

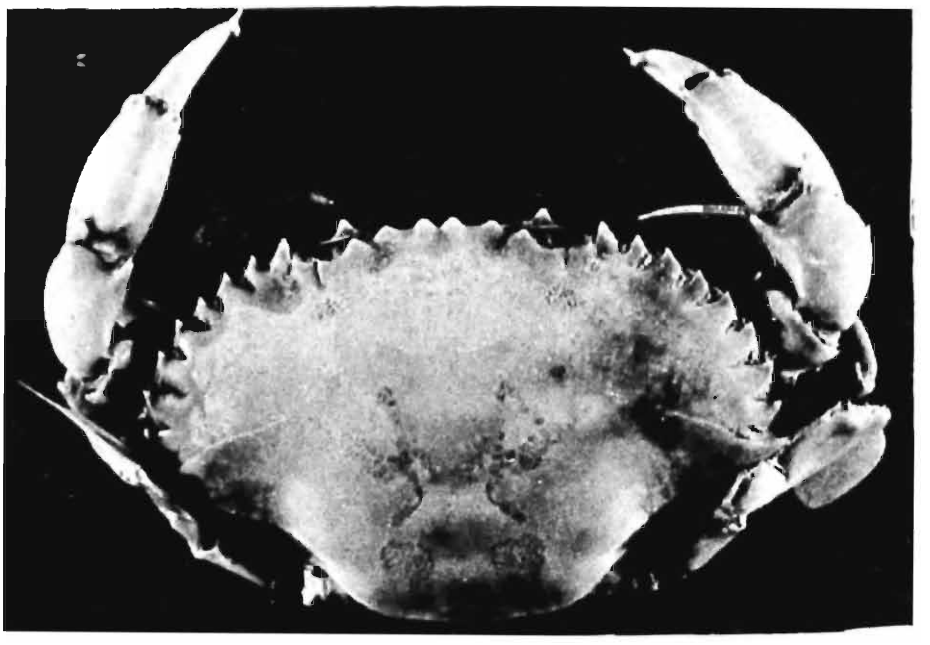

Fig. 1. Bagda, *Penaeus monodon,* Fig. 2. A common edible crab, *Scylla serrata.*